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THESIS

DEVELOPING A MARKOV MODEL TO BE USED AS A FORCE SHAPING TOOL FOR THE NAVY NURSE CORPS

by

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March 2005

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DEVELOPING A MARKOV MODEL TO BE USED AS A FORCE SHAPING TOOL FOR THE NAVY NURSE CORPS

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ABSTRACT

A critical question is determining how the Navy Nurse Corps will meet the challenge of accessing the appropriate number of nurses each year in order to maintain desired end strength. Significant characteristics affecting career progression of individuals in the Navy Nurse Corps were identified. The characteristic of primary concern, accession source, was determined to be significant. Markov models were created to identify personnel flow from ENS through LCDR for each accession source. These models were then combined into a global Markov Model of personnel progression. The final model's end-strength projections for 2006-2009 were compared to Nurse Corps targeted end-strengths for this same period. Several scenarios were run to minimize overages and underages in rank distribution, by changing both the distribution of accession sources and the distribution of recruited ranks. Optimal distribution of accession source and rank are dependant upon the degree of accepTable deviation from the targets set by the Nurse Corps. We were not able to acquire this information, limiting our ability to provide a detailed specific recommendation on the best mix of accession source and rank to meet current targets. The Markov Model demonstrated that the Nurse Corps current business practices optimize accessions for two year projections. Increasing variation between the current force structure plan and our models projections suggest that greater efficiency could be obtained in the out-years. This Markov Model provides a tool for improving extended forecasts.

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DISCLAIMER

This thesis was written by LCDR Dan Kinstler and LCDR Ray Johnson while students at The Naval Postgraduate School studying for a Master's Degree in Business Administration. The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

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I. INTRODUCTION

A. BACKGROUND

As with all forward-looking organizations the DOD (Department of Defense) has made numerous attempts to efficiently manage its human resource capital. Congressional mandates dictate the size and shape of the force for each service. The following discussion highlights recent efforts and how the Navy Nurse Corps has been affected.

On December 12, 1980, Congress enacted the Defense Officer Personnel Management Act (DOPMA)[1]. DOPMA was intended to be the document by which the DOD would govern the number of field grade officers (O-4 through O-6). It was also the intent of congress that DOPMA be used to "maintain a high-quality numerically sufficient officer corps, provide career opportunity that would attract and retain the numbers of high caliber officers needed, and provide reasonably consistent career opportunities among services"[2].

DOPMA has not lived up to its original intent and has caused some selective retention problems for the Nurse Corps. "Service manning documents still reflect the majority of nursing requirements in pay grades O-3 and below, with substantially lower requirements in grades O-4 and above …[and the resulting] lower [promotion] opportunity is causing the services to lose experienced nurses at a time when they are encountering increased difficulty in recruiting nurses"[3]. DOPMA limited the number of O-4 positions thereby resulting in fewer career opportunities. As a result an experienced O-3 is more likely to explore civilian alternatives than take the chance of not promoting to O-4. These concerns are reflected in the words of the Navy Surgeon General, "Retention [of quality nurses] likewise has been crippled by the reduced promotion

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[1] B. Rosker, H. Thie, J.L. Lacy, J.H. Katawa, and S.W. Purnell (1993). "The Defense Officer Personnel Management Act of 1980: A Retrospective Assessment". RAND Documents.

[2] Lt Paul Bedsole. "Total Health Care Support Readiness Requirement" http://das.cs.amedd.army.mil/journal/J9652.HTM; accessed 24 September 2004.

[3] Ibid., p. 6. This view is also expressed by the Navy Surgeon General ("Retention likewise has been crippled by the reduced promotion opportunity resulting from DOPMA restraints.") and the Air Force Surgeon General ("We are also seeking to improve the attractiveness of a career for mid-level nurses by improving their promotion opportunity.") among others. House Armed Committee, 16 March , 1989.

opportunity resulting from DOPMA restraints", and the Air Force Surgeon General, "We are also seeking to improve the attractiveness of a career for mid-level nurses by improving their promotion opportunity"[4]. Although the Nurse Corps is undergoing a mandated reduction in strength, it is important to retain the highest quality individuals.

The Department of the Navy has made every attempt to downsize its force while maintaining optimal readiness. In November of 1999, the Congressional Budget Office (CBO) released its analysis of the drawdown of the military officer corps. This analysis showed that the DOD reduced the number of officers on active duty by 23 percent between 1989 and 1996.[5] The Navy achieved its reduction targets through the use of selective retirement programs and cuts in accessions. In 2002, the Chief of Naval Operations (CNO) released his vision of the U. S. Navy in the 21 century, "Sea Power 21". "Future naval operations will use revolutionary information superiority and dispersed, networked force capabilities to deliver unprecedented offensive power, defensive assurance and operational interdependence to Joint Force Commanders"[6]. The overall impact of Sea Power 21 will be the creation of leaner more effective Navy.

The Navy Nurse Corps (NC) has been slowly making reductions in its officer configuration. In 1994, the NC's end strength was 3,332.[7] In FY04 it had fallen to 3,108 nurses.[8] Additionally, in response to the Chief of Naval Operations guidance provided in "Sea Power 21", cost savings measures through optimization of end strength and alterations in personnel mix are currently under review.

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[4]Navy Knowledge online; https://navalmedicine.med.navy.mil/med.cfm?seltab=bumed&ecmid=93e9008d-802e-d019-abba0925b2764081; accessed 06 June 2004.

[5] Congressional Budget Office Report: http://www.cbo.gov/showdoc.cfm?index=1772&sequence=0; accessed 06 June 2004.

[6] Vern Clark (Admiral U.S. Navy) (2002) Sea Power 21 Series – Part I: Projecting Decisive Joint Capabilities, *Proceedings*, October 2002.

[7] Email from LCDR McDonald, BUMED; received 15 September 2004. "One Page World Book" spreadsheet.

[8] Ibid.

The number of operational billets in the Nurse Corps is defined by Navy Medicine's "Total Health Care Support Readiness Requirement" (THCSRR)[9]. THCSRR is a manpower readiness model that has been adopted by the Military Health service to better define the most efficient and effective mix of manpower readiness requirements. As a result of the study, 115 Nurse Corps billets have been targeted for conversion to Government Service (GS) employees starting in FY06 and running through FY11.

With the challenges of personnel draw down and conversion of some military positions to civilian positions, it is important to assess personnel planning and end strength systematically within the Navy Nurse Corps. The creation of a predictive model would assist in managing the Navy Nurse Corps. By identifying future probabilities of promotion and attrition, a Markov model would be able to predict yearly changes within the Nurse Corps.

B. OBJECTIVES

A Markov Model will be developed to predict Nurse Corps career progression. Regression analysis will then be used to improve validity. By developing this model the following questions can be answered:

- How many nurses must the Navy gain each year to maintain directed end strength and through which of the currently utilized programs, Direct Accession, Recall, Nurse Candidate Program, Medical Enlisted Commissioning Program, and Reserve Officer Training Corps, should they enter?
- Within each accession source, what rank distribution will optimize force structure?

C. ORGANIZATION OF THE STUDY

This paper will include: (1) an overview of the Navy Nurse Corps structure, (2) a Logistic Regression to examine promotion and exit rates at various pay-grades based on accession source and (3) development of a Markov personnel model in an effort to forecast accession goals.

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[9] LT Paul Bedsole "Total Health Care Support Readiness Requirement" http://das.cs.amedd.army.mil/journal/J9652.HTM ; accessed 24 September 2004.

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II. PERSONNEL MANAGEMENT WITHIN NAVAL NURSE CORPS

A. STRUCTURE OF THE NAVAL NURSE CORPS

1. Introduction

The Navy Nurse Corps is part of a team of professionals that provides high quality, economical health care to approximately 700,000 active duty Navy and Marine Corps members, as well as 2.6 million retired and family members at a little more than half the national per capita average cost[10]. This care is provided while supporting contingency, humanitarian and joint operations around the world with highly trained, dedicated health care professionals adhering to the principles of Total Quality Leadership.

2. Accession Sources

Accession source is the avenue through which the Nurse Corps gains new Nurse Corps Officers. It is important to compare costs and benefits of each source to determine which sources are the most cost effective. Six types of accession sources were examined for this study.

a. Naval Reserve Officer Training Corps (NROTC)

NROTC provided the Navy NC with its first accessions in Fiscal Year 1992. The NC community manager sets the quotas for this program while the Chief of Naval Education and Training (CNET) and the Naval School of Health Sciences (NSHS) manage the program. If accepted, candidates have a four-year service obligation on active duty with a total commitment of eight years military service. Candidates receive tuition plus books for 4 years or maximum of 40 academic months and also collect $150.00/month as subsistence. Commissioned at graduation, the candidate may request a

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10 Navy Knowledge online; https://navalmedicine.med.navy.mil/med.cfm?seltab=bumed&ecmid=93e9008d-802e-d019-abba0925b2764081; accessed 06 June 2004.

voluntary delay for active duty for up to 12 months.[11] Overall cost of an ROTC Nurse Corps Officer is $86,000[12].

b. Medical Enlisted Commissioning Program (MECP)

MECP is available to all enlisted personnel in the Navy and the Marine Corps, active and reserve. Historical records show accessions for MECP beginning in1992. The NC community manager sets the quotas for the program while the Naval School of Health Sciences (NSHS) manages the program. Eligible candidates must be high school graduates and have completed at least 30 hours of undergraduate course work that is transferable towards a nursing degree. Upon successful completion, candidates must be commissioned as an Ensign prior to their 35th birthday with an obligation of four years active duty and eight total years of military service[13]. Overall cost of a MECP Nurse Corps Officer is $74,781.[14] It should be noted that this cost includes pay and allowances during the member's enlisted service.

c. Nurse Candidate Program (NCP)

NCP delivered its first accessions into the NC in FY 1993. The NC community manager sets quotas for this source and the program is managed by NSHS. Individuals who make up the pool of candidates for NCP have no prior military experience and if selected must report to OIS (Officer Indoctrination School) prior to their 35th birthday and must be able to complete 20 years of active service by age 55. If candidates are accepted, their obligation is as follows: one year to complete the BSN; four years of active duty and a total of eight years of military service. Two years to complete the BSN will require the candidate to payback five years of active service with eight total years of military service. Overall cost of an NCP Nurse Corps Officer is $30,045[15].

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11 G. Deen & G. Buni. "Development of Steady State Model for Forecasting US Navy Nurse Corps "Master's Thesis, Naval Postgraduate School, Monterey California, 2004.

12 T.K. Maeder. "The Cost and Benefits of the Navy Nurse Corps Accession Sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

13 Maeder T.K. "The Cost and Benefits of the Navy Nurse Corps Accession Sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

14 Ibid.

15 Ibid.

d. Direct Accessions

Direct Accessions are the primary supplements to the training pipeline. Historical starting date for Direct Accessions was not available. Individuals who make up the pool of candidates for direct accessions have no prior military experience and, if selected, must be able to complete 20 years of active service by age 55. Waivers for age can be granted for certain critical specialties. The NC community manager sets quotas and Chief Naval Recruiting Command (CNRC) manages the program. Applicants must be graduates of an accredited U.S. Bachelor's or Master's nursing program. Applicants must also have a current registered nursing license. Service obligation for successful applicants is three years of active duty or four years of active duty if accession bonus is accepted.[16]. Overall cost of a Direct Accession with bonus Nurse Corps Officer is $18,145 and $13,145 without bonus[17].

e. Recalls

Recall is another supplement to the training pipeline that is used to fill critical needs in the NC. Eligible candidates for recall are drawn from the Naval Reserve Force and returned to active duty. Historical starting date for Recalls was not available. The candidate must be able to complete 20 years of service prior to age 55, and must be licensed as a registered nurse. Overall cost for a Recalled Nurse Corps Officer is $10,275[18].

f. Full-Time Out-Service Training (FTOST)

The FTOST program was an accession source used to fill critical subspecialty gasps during the late eighties. No longer available, bringing in its last recruits in 1993, it was managed by Naval School of Health Sciences. Applicants had to be able to complete 20 years of commissioned service by age 55. Participants must have been enrolled or accepted into a Master of Science in Nursing Program and maintain a 3.0 GPA to qualify. While in school, participants received ENS pay (01) and allowances

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16 G. Deen & G. Buni. "Development of Steady State Model for Forecasting US Navy Nurse Corps "Master's Thesis, Naval Postgraduate School, Monterey California, 2004.

17 T.K. Maeder. "The cost and benefits of the navy nurse corps accession sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

18 Ibid.

and also were eligible for promotion. The obligation for this program was 36 months service for the first year and six months for each additional six months in the program.

g. STA-21

The STA-21 is a new enlisted commissioning program (one accession for FY04). Similar to MECP, STA-21 is a full-time undergraduate education and commissioning program open to enlisted personnel of all pay grades and ratings who meet eligibility requirements. The primary difference between STA-21 and MECP is that MECP candidates apply for commission only into the NC, whereas the STA-21 candidate may or may not go into nursing based on the needs of the Navy. Participants in the STA-21 program remain on active duty (receiving full pay and benefits) while attending college and benefit from an education voucher valued at up to $10,000 per year to cover tuition, fees and book costs. While attending school, STA-21 participants drill with a local ROTC unit. Upon completion of their degree, members are appointed as ensigns, U. S. Naval Reserve, on the active-duty list. Overall cost for a STA-21 Nurse Corps Officer is the same as MECP candidates ($74,781) plus up to an additional $10,000 per school year. The number of years it takes to complete schooling varies based upon how much schooling the individual has already completed and the institution attended (usually 2 or 3)[19]. The Nurse Corps is currently projecting 20 accessions per year.

h. Baccalaureate Degree Completion Program (BDCP)

The BDCP provided financial incentives for students completing degree requirements for a Bachelors degree in nursing and obtaining reserve commissions within the Navy Nurse Corps. Applicants had to be commissioned before their 35th birthday, maintain a 3.0 GPA and be able to complete their baccalaureate degree in 24 months. Upon commissioning, individuals were obligated for 48 months. The program ended in 1992.

3. Current Method of Manpower Modeling Within the Nurse Corps and Historical End-Strength

To ensure yearly end-strength goals are met, the nurse corps utilizes the six accession sources previously discussed. Other than historical trends, there currently is no

[19] T.K. Maeder. "The cost and benefits of the navy nurse corps accession sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

formal model upon which gain and loss predictions are based.[20] The spreadsheet in Appendix A (One Page World Book) is the tool currently used by the Nurse Corps to manage the accession process. This spread sheet details the calculations performed to help manage the accession process. The Nurse corps considers MECP, ROTC, NCP, and STA-21 "pipeline programs". The two remaining accession sources, recall and direct accessions, are used as 'valves' to ensure targeted manpower levels are met, leveling out yearly inconsistencies from the pipeline programs.

[20] E-mail from Captain Jaunita Buda, Nurse Corps Community Manager, 28 September, 2004.

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III. LITERATURE REVIEW

A. FACTORS AFFECTING ATTRITION OF NURSE CORPS OFFICERS

1. Introduction

The national shortage of nurses has prompted a growing concern about both retention and recruiting within civilian and military nursing organizations. In an attempt to determine relevant factors related to turnover within the military nurse corps, numerous military specific research papers have examined various characteristics, including demographic variables, accession source, and external market conditions such as the unemployment rate.

2. Demographic Factors

Demographic factors, such as age, race, and gender, are frequently found to be significant influences on an individual's desire to stay in the military.[21] [22] Eleanor Shigley obtained information on 161 nurses who had no obligation to stay in the Navy. Among these individuals, 14 % percent (23 nurses) voluntarily left the Navy while 86 percent (138 nurses) decided to stay. Utilizing a logistic regression with a dependent variable of stay or not stay, being male was found to be a positive significant variable at the .05 percent level.[23] Tables describing the demographics of our independent variables are in the section on Descriptive Statistics.

3. Accession Source

Accession sources are also significant when determining an individual's willingness to stay beyond their initial obligation. Tamara Maeder[24] conducted a study of accession sources for Navy Nurse Corps, comparing different Nurse Corps accession sources in Fiscal years 1992-1994. These accession sources included the Naval Reserve Officer Training Corps, Nurse Commissioning Program, Baccalaureate Degree

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[21] T.K. Maeder. "The cost and benefits of the navy nurse corps accession sources". Master's Thesis, Naval Postgraduate School, Monterey, California, 1999.

[22] Shigley, E "An analysis of factors affecting the career plans of military nurses". Master's Thesis, Naval Postgraduate School, Monterey, California, 1988.

[23] Ibid

[24] T. K. Maeder. "The cost and benefits of the navy nurse corps accession sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

Completion Program, Health Services Commissioning Program, Medical Enlisted Commissioning Program, and Full-Time Out Service Training, and Direct accession. Among these accession sources, Maeder found MECP to have the highest retention rate ($p < 0.01$).[25]

Jonak and Paradis[26] attempted to determine the impact of accession source on career behavior, defined by three critical decision points: completion of initial obligation, retention beyond initial obligation, and promotion to O-4. Multivariate logistical regression was used to show the impact of incremental changes in explanatory variables holding all else constant. Based on their findings, Jonak and Paradis concluded that accession source is a reliable predictor of retention.

4. External Market

The extent to which external market conditions impact a nurse's decision to leave the military has not been determined. Two separate studies, Turner P., and Kocher, K., have found differing results.[27] [28] Turner hypothesized that the probability of a Navy Nurse staying beyond his or her initial obligation was affected by vacancy rates of hospital nursing positions, pay and allowances, and hours worked per week. She examined data from a sample of 702 nurses who responded to a Navy Occupational Task survey in 1987 and performed a logistic regression in an attempt to estimate the probability that a nurse would stay in the Navy, given the independent variables listed above.

Turner's findings were as follows: The number of hours worked and the regional hospital vacancy rates were found to have a negative effect on Navy retention. At a vacancy rate of 11%, nursing vacancy rates negatively affected retention ($p < 0.05$). The

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[25]T.K. Maeder. "The cost and benefits of the navy nurse corps accession sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

[26] P. M. Jonak and R.J. Paradis. "An Analysis of the Effects of Accession Source as a Predictor of Success of Navy Nurse Corps Officers". Master's Thesis, Naval Postgraduate School. Monterey California, 1998.

[27] P. Turner. "Retention in the navy nurse corps". Master's Thesis, Naval Postgraduate School. Monterey California, 1990.

[28] K. Kocher and G. Thomas. (1994) Retaining army nurses: a longitudinal model. Research in Nursing & Health (17) 59-65.

number of hours worked demonstrated a negative relationship to the probability of a Navy Nurse Staying (p = 0.06). Pay demonstrated a positive relationship at the .05 significance level.

In their 1994 publication Kocher and Thomas examined the effects of external market factors, personal factors, and work related factors on an individual's stay/leave decision. Obtaining information from a DOD mandated survey, a randomly selected sample of 158 junior Army Nurse Corps officers (2nd Lieutenant, 1st Lieutenant, and Captain) eligible to leave the Army and who would have served less then 10 years was used. They found significant variables to include race, assignment stability, and satisfaction with military life (p < or = to 0.05); being married with children was significant at .01 percent level. External market factors, measured by respondents' self-reported likelihood of obtaining a good civilian job and the individual possessing a nursing subspecialty, where found to be insignificant.

B. MARKOV MODEL

1. Introduction

A Markov Model is a simulation based on Markov Chains. Developed by Andrei Markov (1856-1922), a Markov Chain defines probabilities of future conditions relative to the current characteristics of a specific time period or state, independent from the history of the system.[29] Scientists and engineers frequently use these models to analyze both the time dependent development of a system and the characteristics of its steady state, the point at which it no longer changes.

A Markov decision process has three components: a set of states, an action, and the effect of the action. These can be depicted in a cross sectional matrix. For example, within the nurse corps, at any given time period there are a number of individuals in a specific rank (ENS, LTJG, LT, LCDR, etc). Within a designated time period, it can be

[29] OneLook Dictionary http://cancerweb.ncl.ac.uk/cgi-bin/omd?markov+chains; accessed 29 September 2004.

expected that a certain number of individuals will advance in the system and a certain number of individuals will move out of the system, resulting in a new mix of personnel in each rank.

Within a cross sectional matrix, the coefficients in the matrix refer to the probabilities with which members move to different states, or as in the example above, ranks. As a time-dependent model, personnel movements can be projected from year to year. This provides not only a forecast of distributions but a means for adjusting the transition probabilities to reflect changing institutional conditions or policies. Probabilities of changing to different levels are calculated from various variables that cause switching, for example, pay, gender, age, education, etc. For example, if the probability that an individual stays at his/her current status as an ENS is 0.90, the corresponding probabilities of his/her changing to other levels, LTJG, LT, LCDR, and Out, may be 0.08, 0.00, 0.00, and 0.02 respectively. Thus, a probability matrix can be constructed as follows:

Time Period (t)

		To				
		ENS	LTJG	LT	LCDR	Out
	ENS	0.90	0.08	0.00	0.00	.02
	LTJG	0.01	0.90	0.07	0.00	.02
From	LT	0.00	0.02	0.70	0.10	.18
	LCDR	0.00	0.00	0.02	0.92	.06
	Out	0.00	0.00	0.00	0.00	1.0

2. Historical Usage of the Markov Process in Manpower Modeling for the Nurse Corps

Glenn Buni and Gary Deen developed a deterministic Markov model for the flow of Navy Nurse Corps officers from the rank of O-1 through O-3. Using panel data from fiscal years 1990 through 2003 consisting of professional characteristics, such as date of rank and accession source, Deen and Buni were able to develop a steady state for these three ranks.

In addition to Buni and Deen's work there are numerous examples of Markov Models used in Manpower Analysis and other fields. In his thesis titled "Development of Spreadsheet Models for Forecasting Manpower Stocks and Flows", Earl (1998)[30], develops computerized manpower planning models. These models were developed for use by the Naval Postgraduate School's manpower curriculum students in the Manpower Personnel Models course. This course is designed to introduce students to basic manpower modeling concepts and utilizes Microsoft Excel™. This thesis was referenced to help in the design and implementation of our modeling process.

Grinold and Marshall[31] wrote *Manpower Planning Models* in 1977. This text was one of the first to directly address the topic of manpower planning. At the time it was written, this type of planning was becoming a concern to Federal, state, and local governments, industrial organizations, the armed services, and educational institutions. The book was written to be used as either a reference for manpower planners or as a textbook for manpower planning courses.

In August of that same year Marshall wrote a technical report titled *An Interactive Model to Compute the Officer Manpower Plan for the United States Marine Corps.*[32] This report developed a computerized Markov type process by which the Marine Corps could calculate the "...future forecasted and planned force structure by rank" in about five minutes. This innovative process allowed for multiple iterations in a short period of time. Marshall also produced a similar report titled *Forecasting the Numbers and Types of Enlisted Personnel in the United Sates Marine Corps: An Interactive Cohort Model.*[33]

In 1997 Reeves and Ried[34] wrote an article titled *A Military Manpower Reserve Manpower Planning Model.* The article focused on developing a multiple objective

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30 Michael G. Earl. "Development of spreadsheet models for forecasting Manpower stocks and flows". Master's Thesis, Naval Postgraduate School. Monterey California. 1998.

31 Richard C. Grinold and Kneale T. Marshall. (1977) Manpower Planning Models. North-Holland: New York.

32 Kneale T. Marshall (1977) An interactive model to compute the officer manpower plan for the United States Marine Corps. Technical Report. Naval Postgraduate School, Monterey California.

33 Kneale T. Marshall (1977) Forecasting the Numbers and Types of Enlisted Personnel in the United Sates Marine Corps: An Interactive Cohort Model. Technical Report. Naval Postgraduate School, Monterey California

34 Gary R. Reeves and Randall C. Reed (1999). A military reserve manpower planning model. Computers and Operational Research. 26:1231-1242

manpower planning model for a smaller reserve unit (100 people). The model was developed interactively with U. S. Army Reserve officers prioritizing solutions from least to most preferred. The authors concluded that the system that was developed could improve both the consistency and quality of the personnel decisions.

3. Summary of Prior, Related Thesis Research

Deen and Buni validated their model (FLORENCE) by comparing FLORENCE's predictions for FY 2003 using input data from FY2002 to actual stock for FY 2003. Variances between the two sets of numbers was reported at <10 percent which was felt to be reasonable.

FLORENCE's initial result using FY 2002 as initial manning data and using accession values provided by the NC Community Managers Office (considered the base case of the model) predicts that there will be too many Ensigns and too few LTJGs and LTs as compared to desired manning levels. Steady state for O-1s and O-2s was reached at 9yrs and O-3s achieved steady state at the 17 year mark and resulted in a significant shortage of LTs with a corresponding excess of Ensigns. This initial mix results in a junior force and the potential for a shortage of experienced, high quality individuals to fill senior leadership positions.

In order to deal with this issue two scenarios were developed. The first examined a reduction in accessions by fifty percent. Shortages were created in mid-grade officers but resulted in a more senior force. Secondly, planned accessions were split between Ensigns (two thirds) and LTJGs (one third). This accession mix produced numbers more reflective of desired end strength.

Based on and initial analysis of the Bureau of Medicine and Surgery Manpower Information System (BUMIS) data, the 10-year retention patterns for the FY 90-94 year groups showed that a nurse who was accessed through RECALL and MECEP were consistently more likely to stay than other accession sources. BUMIS is an automated information system (AIS) maintained by the Bureau of Medicine and Surgery (BUMED) of the United States Navy. At the 5-year mark in the FY 96-98, NCP accessions were more likely to stay. Deen and Buni believed that considerations should be given to maximizing recruitment through these sources. Additionally, NC officers who pursued

higher education were less likely to stay. These individuals are likely to be the high quality officers desired for retention and promotion to senior ranks and efforts should be made to retain them.

4. Advances and Extensions in Current Research

This thesis advances Deen and Buni's research in several areas. The addition and merging of DMDC data with BUMIS data allows us to address several issues raised by Deen & Buni in their considerations for future research. In particular the dependent variable (leave, promote) of the analysis (Markov and statistical) is redefined, additional independent variables are included, and accessions to other levels such as, LTJG, LT and LCDR are added.

Deen and Buni's dependent variable, years of service, as constructed was not optimal. Deen and Buni recommended that future studies should include a variable that would not be constrained by FY but based on time periods related to dates of entry. This issue was addressed constructing a variable based on "time in rank". This variable will be further defined in a later section.

Deen and Buni also described important variables used by Maeder (1999). These variables include prior service, dependants, older individuals and gender and were unavailable to Deen and Buni. Maeder found these variables to increase the probability of staying. The DMDC data base also allowed us to include these additional variables used in Maeder's (1999) work.

Deen and Buni's study assumed that all accessions were Ensigns. This was due to the fact that the BUMIS data base was incomplete. This problem was addressed by obtaining the DMDC data base and merging the two. This process will be fully defined later. In addition to these changes, a new Markov model formulation was used.

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IV. METHODOLOGY

A. INTRODUCTION

Two data bases were used for this study; BUMIS and the Defense Manpower Data Center (DMDC) Master File. BUMIS stores historical data pertaining to individuals assigned to BUMED. The DMDC data set was provided by the DMDC field office of Monterey, California. DMDC was established in 1974 to support the information management needs of the Office of the Under Secretary of Defense for Personnel and Readiness (OUSD, P&R). Department of Defense Instruction 1336.5[35] provides the guidelines followed by the services when compiling the data that they send to DMDC. The mission of DMDC can be summarized as follows:

- Collect and maintain an archive of automated manpower, personnel, training, and financial databases for the Department of Defense.
- Support the information requirements of the OUSD (P&R) and other members of the DoD, manpower, personnel, and training communities with accurate, timely, and consistent data.
- Operate DoD-wide personnel programs and conduct research and analysis as directed by the OUSD (P&R).

B. MERGING DATABASES AND CREATING INDEPENDENT VARIABLES

To obtain a single data base containing only the variables of interest to the study the following steps were taken:

1. Merge the Databases

The DMDC and BUMIS data bases were merged into a single data base using social security numbers as identifiers, resulting in a "Combined Data Base" (CDB).

2. Incorporate Overlapping Years Only

Years for which data were not available in both data bases were deleted. DMDC data covered years 1981 through 2001. BUMIS data covered years 1990 through 2003. The CDB now contains only data for the years 1990 through 2001.

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[35] Washington Service Headquarters website, http://www.dtic.mil/whs/directives.

3. Eliminate Duplicate Variables and Variables of No Interest

Many of theses variables were a product of duplication and were easily combined. For example, if an individual was a "female" for gender, the CDB provided 12 gender variables for each individual, one for each year. Since gender does not change, these 12 variables (1990-2001) could be combined into one. This process greatly reduced the number of variables. A complete list of combined variables is available in Appendix B

There were many variables in the original data files that were unlikely to have any influence on an individual's decision to stay in the Nurse Corps and these were eliminated Examples of such variables include second language, ASVAB scores, unit zip code etc. A complete list of all deleted variables is included Appendix B.

4. Construct New Variables of Interest

Some variables thought to affect an individual's decision were not in the CDB directly and had to be constructed. Civilian unemployment rate (unem), for example, was used as a proxy for an individual's ability to get a non-nursing job within the civilian sector should they decide to leave the military. Information for national unemployment rate was obtained from the Bureau of Labor and Statistics and matched with the appropriate fiscal year within the CDB.

Six subspecialties were identified by the literature as being "critical" to the Nurse Corps during times of increased operational commitments[36]. Critical subspecialties included Medical/Surgical Nurse, Psychiatric Nurse, Emergency/Trauma Nurse, Perioperative Nurse, Critical Care Nurse, and Nurse Anesthetist. A new variable (critical) was created that would identify an individual as having one of these subspecialties.

A "time in rank" variable was created so it could be determined how long an individual was at that rank before being promoted, leaving the service or moving to the next group in the matrix (staying). Both databases use letters to indicate the rank of an individual officer in the following manner: L = Ensign (O-1), K = Lieutenant Junior

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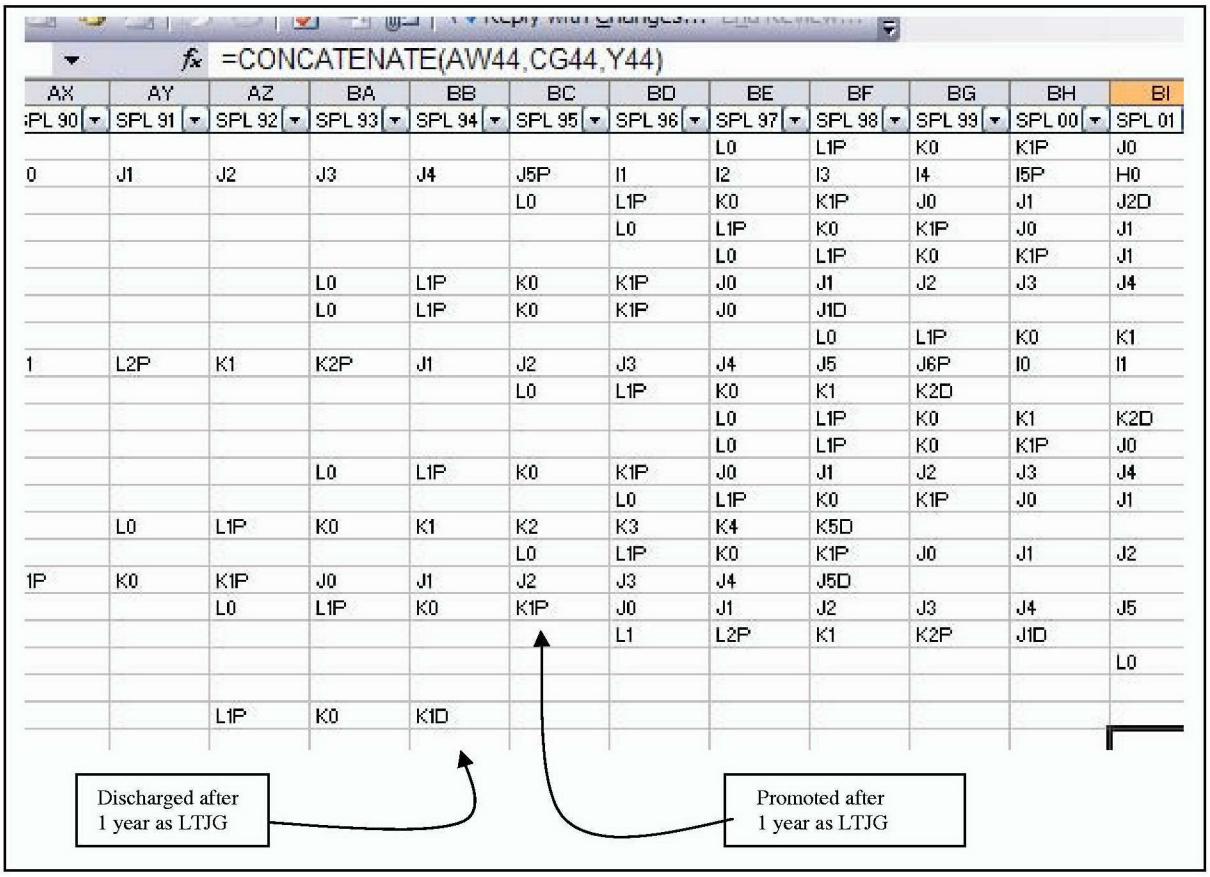
[36] Navy Nurse Corps Manpower Update: https://bumed.med.navy.mil/med00nc/Newsletters/2003/Nov%2003/nov%202003.html# Detailer's%20Message.

Grade (O-2), J = Lieutenant (O-3), and I = Lieutenant Commander (O-4). As an example, the variable L0 indicates an ensign with less than one year of service. An L1 indicates an ensign who has completed one year of service but less than two years etc. APPENDIX C contains a complete list of independent variables.

5. Eliminating Inappropriate Data

MicroSoft Excel "Autofilter" function was used to initially scrub the variables. The results were validated using Excel "CONCATENATE" function and SAS® demographic functions. "CONCATENATE" allows for a combination of variables to appear as a one cell entry. Individual rank, years at rank and promotion or discharge variables were combined into one cell. Expecting an orderly flow of years in rank (L1, L2, L3, etc.), promotions preceding rank changes, and discharges preceding empty cells, the data was visually examined for discrepancies. A screen shot providing a partial view of this information is provided below in Chart 1.



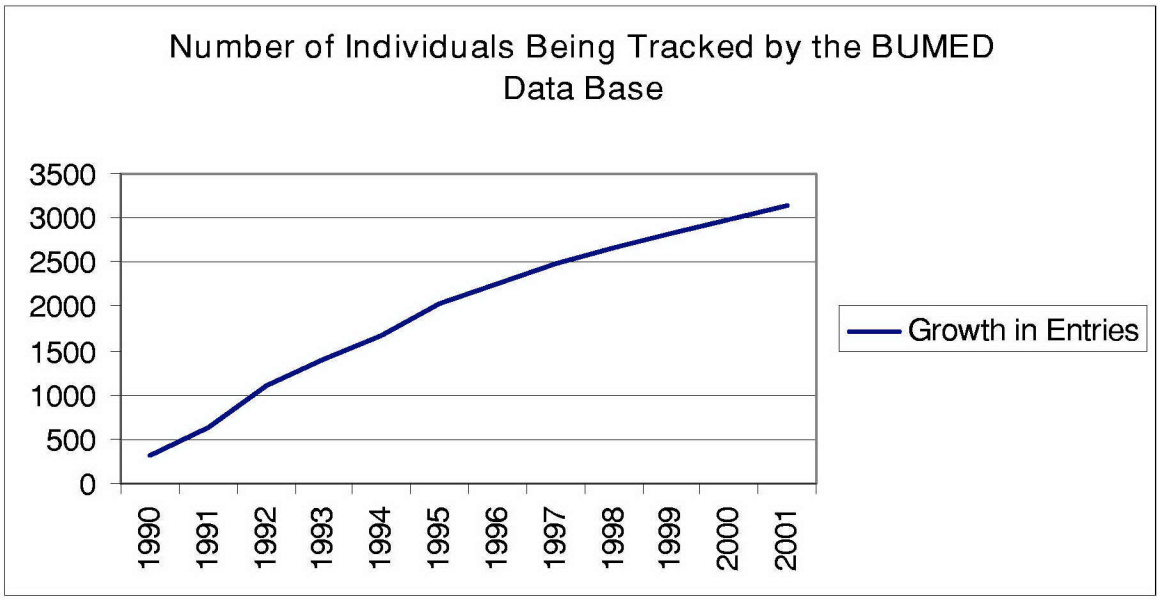
AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
SPL 90	SPL 91	SPL 92	SPL 93	SPL 94	SPL 95	SPL 96	SPL 97	SPL 98	SPL 99	SPL 00	SPL 01
							L0	L1P	K0	K1P	J0
0	J1	J2	J3	J4	J5P	I1	I2	I3	I4	I5P	H0
					L0	L1P	K0	K1P	J0	J1	J2D
						L0	L1P	K0	K1P	J0	J1
							L0	L1P	K0	K1P	J1
			L0	L1P	K0	K1P	J0	J1	J2	J3	J4
			L0	L1P	K0	K1P	J0	J1D			
								L0	L1P	K0	K1
1	L2P	K1	K2P	J1	J2	J3	J4	J5	J6P	I0	I1
					L0	L1P	K0	K1	K2D		
							L0	L1P	K0	K1	K2D
							L0	L1P	K0	K1P	J0
			L0	L1P	K0	K1P	J0	J1	J2	J3	J4
						L0	L1P	K0	K1P	J0	J1
	L0	L1P	K0	K1	K2	K3	K4	K5D			
					L0	L1P	K0	K1P	J0	J1	J2
1P	K0	K1P	J0	J1	J2	J3	J4	J5D			
		L0	L1P	K0	K1P	J0	J1	J2	J3	J4	J5
						L1	L2P	K1	K2P	J1D	
											L0
		L1P	K0	K1D							

Chart 1. Partial Screen Shot Showing CONCATENATE Function of data

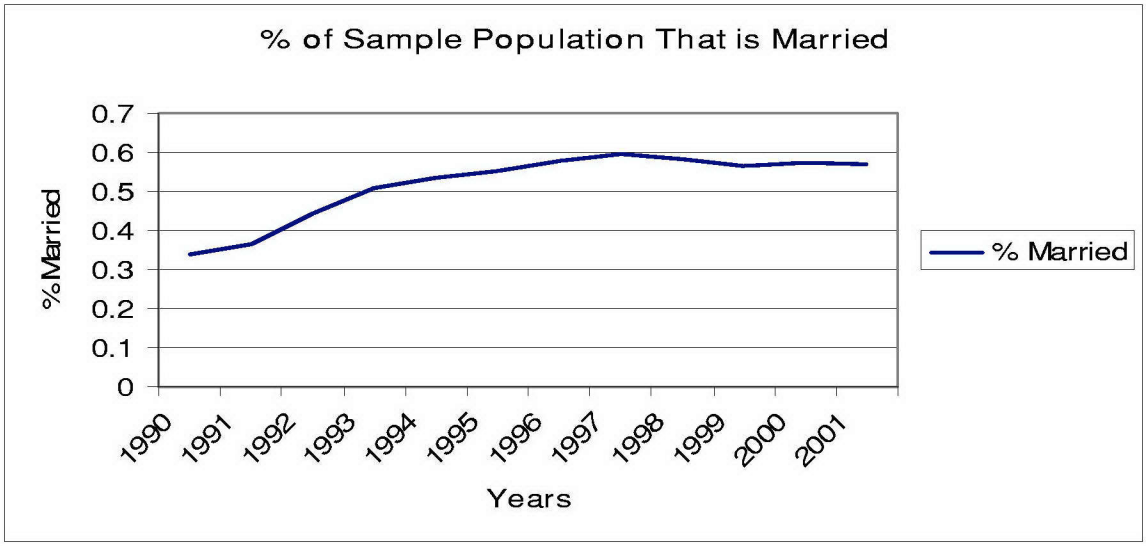
The following discrepancies were noted: One hundred individuals had only blank cells and were eliminated. Fifteen "years in rank" entries were found to have lapses. For example, entries went from J1 to blank cells, to J4. These entries were corrected or deleted as appropriate. Ten entries were inappropriately labeled as discharges and because information was continuing to accumulate for these individuals these discharges were voided and the individuals were considered to be on active duty. Ten entries had 99 listed for the number of dependents and were set to zero. In fiscal year 2001, gender coding was changed from numeric to alpha "M" and "F" and changed back to numeric to match previous years. Fiscal year entries for 2000 and 2001 were coded "0" and "1", this was changed to "2000" and "2001".

C. DESCRIPTIVE STATISTICS

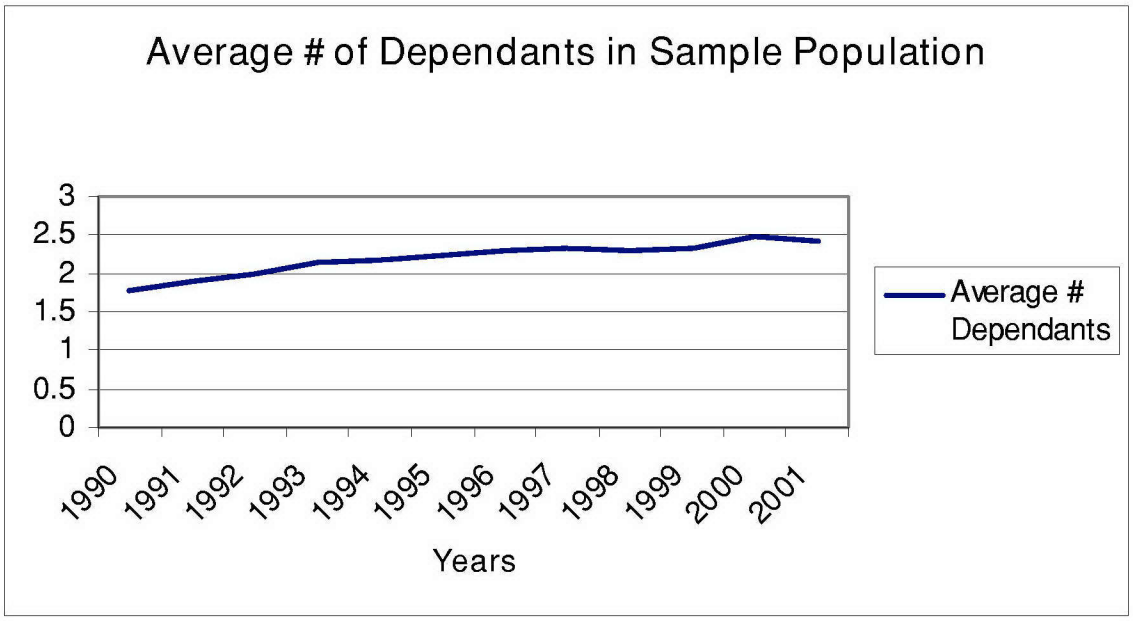
Initial review of the descriptive statistics revealed some unexpected results. First, despite end strength of just over 3,000 nurses there were only 389 nurses entered into the data in 1990. The number of entries increased each year, reaching 2,236 nurses in 2001, but never reaching the full population size resulting in an increasing longitudinal database (see graph 1 below). However, once a person was entered into the database, they were followed until discharge from the Navy Nurse Corps. For a distribution of rank by fiscal year see Appendix D. Second, possibly due to this first result, it was discovered that there are no Captains (O-6s) in the combined databases. There were a small number of Commanders (O-5) but since there are no Captains we do not know what happens to them. Thus, we are unable to track individuals past Lieutenant Commander (O-4). Following are the key demographics generated by the Descriptive statistics:



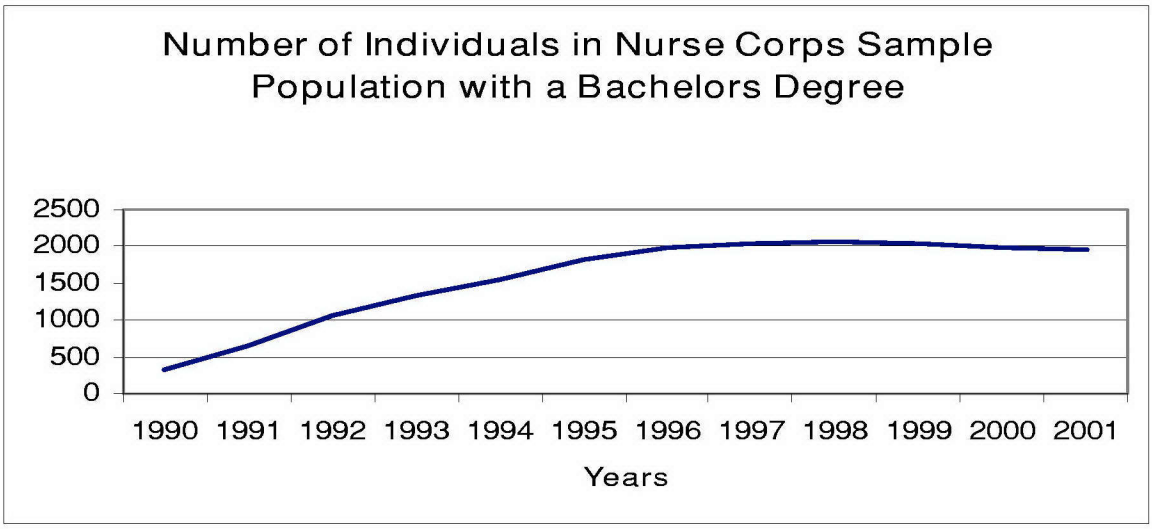
Graph 1. How the BUMED database has been built over the years.



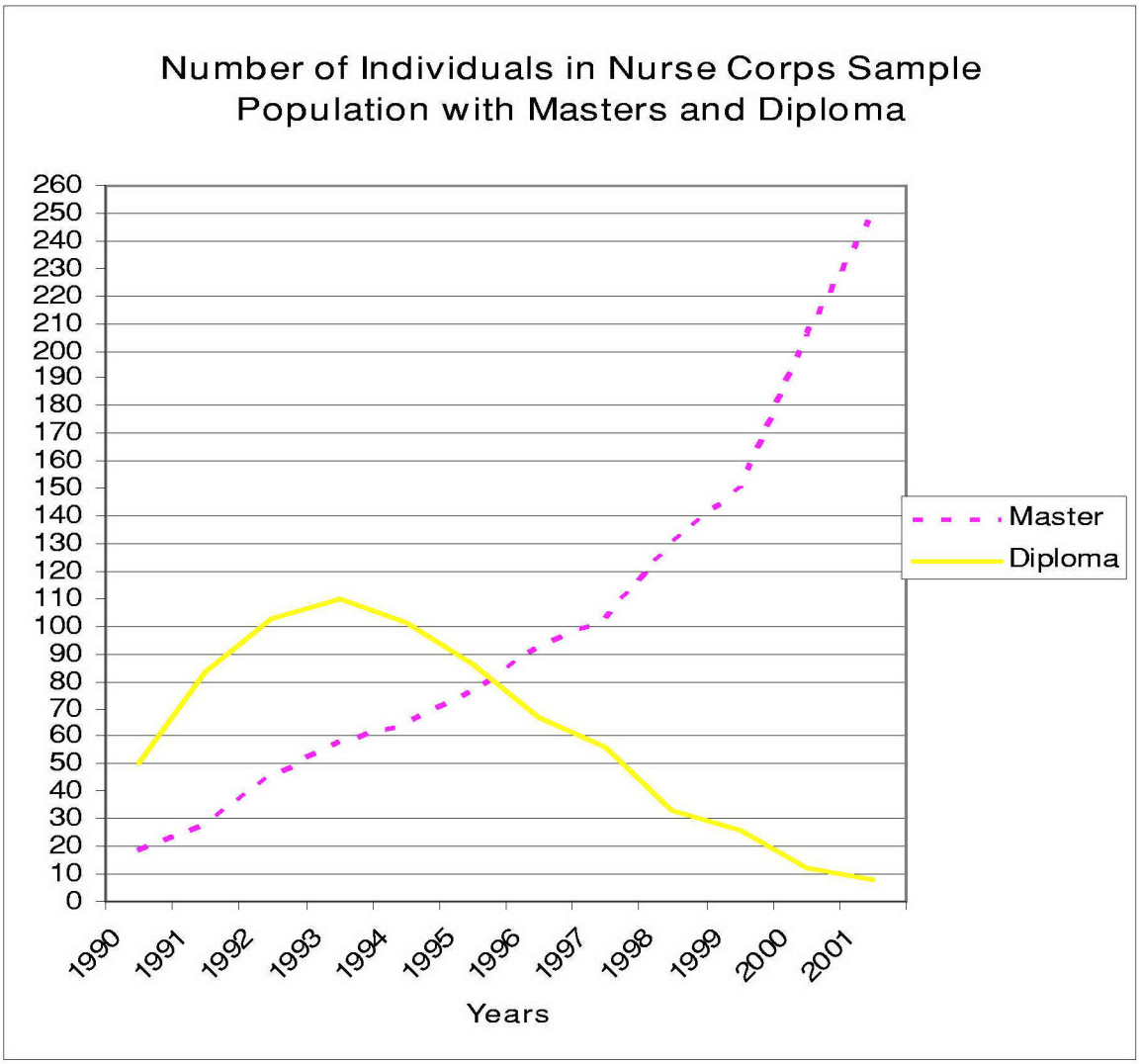
Graph 2. The percentage of individuals in the CDB that are married. As the graph shows, the percentage of married individuals plateaus at approximately 60 percent in 1998.



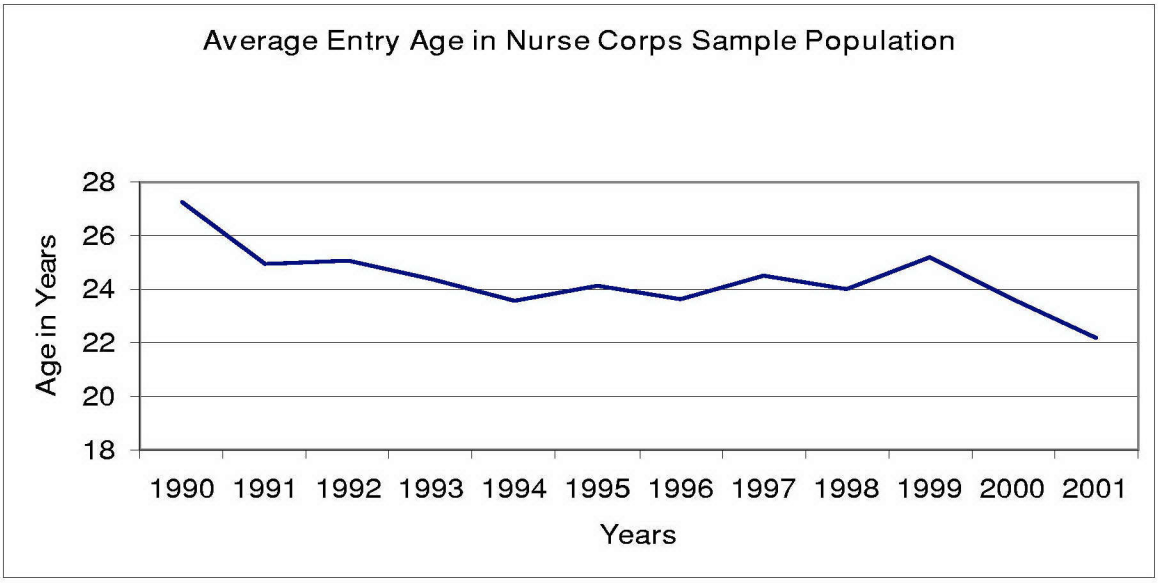
Graph 3. The average number of dependants for each individual in the CDB was between 1.5 and 2.5 from 1990 through 2001.



Graph 4. In 1997 the number of individuals that have bachelor's degree as their highest level of education leveled off at approximately 2000.



Graph 5. Between 1993 and 2001 there has been a significant increase in the number of individuals with a master's degree and a decrease in the number of individuals with a diploma. (The "diploma degree" consisted of a 3-year on the job training program which when successfully completed authorizes the individual to take the Registered Nurse exam. This type of program has been phased out).



Graph 6. The average age of entry into the Nurse Corps has remained relatively sTable from 1991-2001.

D. MODEL BUILDING FOR REGRESSION ANALYSIS

This study uses logistical multivariate modeling techniques and statistical analysis to evaluate the significance of accession sources in relation to individuals leaving and promoting within their career path. The effects of individual characteristics (independent variables) such as marital status and level of education are entered into the regression model to control for extraneous characteristics that may also have an effect on an individual's desire to leave or propensity to promote. Table 1 summarizes the hypothesized effects that the individual independent variables will have on the dependent variable.

	Dependent Variable: Leaving A positive value means a person is more likely to leave				Dependent Variable: Promoting A positive value means a person is more likely to promote				
	3rd Year LTJG	1st Year LT	2nd Year LT	3rd Year LT	1st Year ENS	2nd Year ENS	3rd Year ENS	3rd Year LTJG	6th Year LT
Direct , No Bonus									
BDCP									
Direct, Bonus									
NCP									
FTOST									
MECP	-	-	-		+	+			
Recall	-	-			+	+			
Male	-	-	-						
White									
Active SP									
Diploma					-	-	-	-	-
Master								+	+
Critical									
Unemp			-	-					
Dependence	-	-	-	-					
Married									
Entry Age	-	-							

Table 1. Hypothesized relationship between the independent variables and the dependent variables (if blank, the hypothesized relationship is unknown)

1. Expected Relationships of Accession Source

Accession source is the only factor in the recruitment process for which quotas are filled. All accession sources are included on our models since it is a variable that is easily manipulated by the Nurse Corps. It is unclear how accession source in general will affect career progression. However, there are some expectations. It is estimated MECP, prior enlisted individuals coming into the nurse corps, and recalled individuals will have a significant positive effect on promotion and retention during the first few years of their career. Historically, MECP has been the most reliable accession source in predicting whether or not individuals will stay beyond their initial obligation[37]. Individuals accessing through the MECP program have already shown a tendency towards a military career as explained above. Because the individual is familiar with the military lifestyle, it is expected that individuals recalled to active duty will have improved retention during the first few years of their career.

2. Gender and Immediate Family Membership

Literature has shown that gender and marital status play significant roles in choosing and remaining in the military. Males typically show a greater tendency to pursue military careers[38] [39] [40]. Our preliminary regressions also indicate that individuals who are married also tend to stay in the military at a higher rate than those who are not. Members with dependants (dep) are also thought to be less likely to leave the military, due to increased financial security and benefits. It is unclear what members with active duty spouses (ActiveSpouse) will do. Frequent deployments of one or both of the individuals may encourage attrition due to broken family life, especially if children are present. However, predisposition to military life style and financial security may encourage retention.

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[37] T. K. Maeder. "The cost and benefits of the navy nurse corps accession sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

[38] Waite and Berryman "Women in Nontraditional Occupations" Rand, 1985.

[39] T. K. Maeder. "The cost and benefits of the navy nurse corps accession sources". Master's Thesis, Naval Postgraduate School. Monterey, California, 1999.

[40] E. Shigley. "An analysis of factors affecting the career plans of military nurses". Master's Thesis, Naval Postgraduate School, Monterey California, 1988.

3. Education and Subspecialty Codes

In deciding whether or not to stay in the military, an individual must consider the job opportunities in the civilian sector. In the nursing profession as in other professions educational level and area of expertise may play an important role in marketing ones self. Presently the minimum educational level for entrance into the Navy Nurse Corps is a bachelor's degree which is our base case for educational level. Also included in our database are holders of masters and diploma degrees (Master, Diploma). For a definition of Diploma see graph number 4. There are relatively few civilian nursing positions which require a Master's Degree, however, Master's Degrees are required for promotion to the O-5 level in the Nurse Corps.

In the nursing profession the number of specialties is large. However, the Navy has identified six specialties that it feels are vital to its mission. We have included these specialties (critical) in our model. We believe individuals with this characteristic will be less likely to leave since the Nurse Corps will be more likely to make an effort to keep them.

4. Desire to Leave Nursing

It is expected that national unemployment (unem) will have a positive relation to retention. In this study, national unemployment rate is intended to capture an individual's ability to attain a non-nursing related job within the civilian sector that is if he or she wishes to leave nursing as a profession. Employment opportunities within nursing specific positions are not expected to be a factor since job opportunities for nurses in the civilian sector have remained consistently high over the last 30 years.

5. Entry Age

Entry age (Entry_Age) has been shown to have a significantly positive relationship to retention[41]. Older individuals are more likely to make more informed career choices and historically show a greater tendency to stay. We believe that older accessions will have a greater tendency to stay.

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[41] Scott E. Payne. Socioeconomic Determinants Impacting Air Force Officer Retention, Master's Thesis, Naval Postgraduate School, Monterey California, 1988.

E. REGRESSION ANALYSIS

The dependent variables used in the logistic regressions were leaving and promoting. As discussed in section IV-C, the CDB was populated gradually through the 90's. This resulted in instances of very small samples for some modules. In particular, since individuals are followed through time and since most entries are in the lower ranks (0-1 through 0-3), the greater the rank and years in service, the fewer the observations due to attrition. In addition, for some pay-grade and year combinations, it is very unlikely to promote or leave. If there were no promotions and/or no leaving (exiting the Nurse Corps) then there were no instances of the dependent variable occurring.

We chose to follow a statistical rule of thumb which states that the number of independent variables should be approximately less than or equal to ten percent of the number of observations. Based on this guidance, we were only able to perform ten regressions, 3rd year Lieutenant Junior Grades leaving, 1st, 2nd, 3rd, and 4th year Lieutenants leaving, 2nd and 3rd year Ensigns promoting, 2nd and 3rd year Lieutenant Junior Grades, and 6th year Lieutenants promoting. See Table 2 below.

	ENS (2 yr)	ENS (3 yr)	LTJG (2yr)	LTJG (3yr)	LT (1 yr)	LT (2 yr)	LT (3 yr)	LT (4 yr)	LT (6 yr)
Promoting	2771	549	2623	827	-	-	-	-	595
Leaving	-	-	-	827	1977	1880	1493	1154	-

Table 2. Number of Observations in each Regression

Utilizing a Logistic Regression model, heteroskedasticity, and functional form were not evaluated. Heteroskedasticity is never an issue in logistic regression due to the fact that there are only two possible responses, in this case leave or not leave. The nature of the independent variables makes it difficult to alter model specification significantly. In addition, omitted variable bias may be present but we are choosing not to address it at this time. The partial effects of the variables were not calculated because they are not needed for the creation of a Markov Model. Selection bias does pose potential problems because we were unable to determine the process utilized in constructing the initial BUMED database. As previously noted, the database was gradually built with new

entries being added every year. The base case was a single, black female with a Bachelor's degree who had accessed through ROTC and is a general nurse.

F. REGRESSION RESULTS

Table 3 below summarizes all of the significant variables resulting from the ten regressions. The complete list of Likelihood estimates can be seen in Appendix G.

1. Discussion of Independent Variables

Our variable of primary concern is accession source, all other variables are included as controlling factors for the significance of accession source. In summary, it can be noted that accession source does significantly impact the probability of a person leaving. Some of this can be correlated with the corresponding contracts for each accession source, resulting in negative estimates in the earlier years, such as 3rd year LTJG. Accession source also has shown to significantly impact promotion rates. However, there does not appear to be a clear pattern.

Prior to conducting the regressions, MECP was the only accession source for which we had a clear expectation of its effect on the propensity to leave. As stated in section IV-D, we felt that MECP accessions would be significant and these individuals would be less likely to leave (negative coefficient) and more likely to promote (positive coefficient).

Unexpectedly, MECP behaved sporadically. For leaving, it was never significant at the five percent level; the coefficient was positive for J0s and J1s and negative for J2s, J3s, and K2s. For promoting, L2s and K1s were the only groups that had a significant effect on promote; L2s were less likely to promote and K1s were more likely to promote.

Accession source was found to be a significant factor in all regressions regarding leaving and in nine out of ten regressions pertaining to promotion. These results are important to the development of a Markov Model because the Nurse Corps, by controlling accession source, could influence personnel flow as reflected in the Markov Model.

Likelihood Estimates for Significant Variables

* Significant at .05 Level
** Significant at .01 Level

	Leaving					Promoting				
	3rd Year LTJG	1st Year LT	2nd Year LT	3rd Year LT	4th Year LT	1st Year ENS	3rd Year ENS	2nd Year ENS	3rd Year LTJG	6th Year LT
Direct, No			1.41 *	1.23 '*		-1.00 **		-.59 **		
BDCP		1.59 **	2.00 *	1.25 **					-.89 *	
Direct, B	-1.50 *	.98 **	.73 *			-.90 **		-.50 **	.80 *	
NCP	-2.96 **		1.02 **			-.76 **				
FTOST	-2.96 **				2.62 *	-1.35 *	2.62 *			
NECP								.38 *		
Recall	-3.89 **							-.71 *	1.88 *	
Male			-.57 *			-.22 *		-.23 *		-.50 *
White						.41 **				.65 *
Active Sp		-1.61 **	-1.73 *					.52 **	1.92 **	
Diploma										-.87 *
Master										1.03 **
Critical		-.49 *	-.43 **					.43 **	.74 **	
Unempl	.74 **	.35 *	.50 **	.422 **	.672 *	.12 *	.67 *	-.13 *	-.27 *	-1.24 **
Dependence		-2.32 **	-3.55 **	-2.70 **	-3.86 **	-.11 *	-3.86 **	.15 **	1.01 **	.27 **
Married			-1.12 *			.05 **				
Entry Age										.03 *

Table 3. Likelihood Estimates for Significant Variables

a. Independent Variables, Accession Source (Dependent Variable Being Leaving)

Below is a summary of the regression findings for accession source with leave as the dependant variable and reflecting the two-tailed test. A negative coefficient indicates that individuals accessed through this source were less likely to leave. Coefficients are in parenthesis.

Third Year LTJG Leaving – Recalls (-3.89) and NCanProg (the variable for NCP)(-2.96) are significant at all levels and DirectBonus (variable for Direct Accession with Bonus) (-1.51) at the 5 percent level.

First Year Lieutenants Leaving – BDCP (1.59) and DirectBonus (0.98) are significant at all levels.

Second Year Lieutenants Leaving – DirectNoBonus (variable for Direct Accession without a bonus) (1.41), BDCP (2.01), and NCanProg (1.03) are significant at all levels. DirectBonus, (0.75), is significant at the five percent level.

Third Year Lieutenants Leaving – BDCP (1.26) is significant at all levels. DirectNoBonus (1.24) is significant at the five percent level.

Fourth Year Lieutenants Leaving – FTOST (2.61) is significant at the five percent level.

b. Independent Variables, Accession Source (dependent variable being promoting)

Below is a summary of the regression findings for accession source with promote as the dependant variable and reflecting the two-tailed test. A negative coefficient indicates that an individual accessed through this source is less likely to promote.

Second Year Ensign Promoting – DirectNoBonus (-1.00), DirectBonus (-.90), and NCanProg (-0.76) are significant at all levels. FTOST (-1.35) is significant at the five percent level.

Third Year Ensign Promoting – FTOST (2.62) is significant at the five percent level.

Second Year LJTG Promoting – DirectNoBonus (-0.59) and NCanProg (-0.50) are significant at all levels. MECP (0.38) and Recall (-0.72) are significant at the five percent level.

Third Year LTJG Promoting – BDCP (-0.89), DirectBonus (0.80) and Recall (1.88) are all significant at the five percent level.

Sixth Year Lieutenants Promoting - There were no significant accession sources at any level.

c. Independent Variables, Race and Gender

Race- Literature has shown that race typically affects the decision to leave with minorities being less likely to leave. Our model did not mirror these findings, White was not significant in any of these models. The literature also demonstrates that males have a tendency to stay in the military as well compared to females. In our study, Male was significant in only two cases, J2s at the five percent level and J3s at the one percent level. Both cases indicate males are less likely to leave than females. We believed that male would be significant in every case and it was not.

d. Independent Variables, Marital Status and Number of Dependents

Marital status (Married) was significant and negative for J1s, J2s at the one percent level and J3s at the five percent level indicating that individuals who are married are less likely to leave. This finding was expected but it was not as significant as it was expected to be. It is believed that the more dependants (dep) an individual has the less likely he or shed is to leave. Dep was significant in each case and those with dependants were less likely to leave as expected. Individuals with active duty spouses were also expected to be less likely to get out and the results supported this assumption.

e. Independent Variables, Educational Level and Possession of a 'Critical' Sub-Specialty

Educational level was thought to have a small negative effect on the decision to leave but in each case these variables were insignificant. Subspecialty (critical) was anticipated to have a small negative effect on the decision to leave as well. Critical was significant at the five percent level for J1s, J2s, and K2s and indicated that

these individuals were less likely to leave than the base case, non-critical subspecialty. These results may be due in part to efforts made to retain these people.

f. Independent Variables, Entry Age and National Unemployment Rate

The older an individual (ENTRY_AGE), the less likely it was thought that he or she would be to leave. In each case, however, entry age proved to be insignificant. Finally, it was thought that the national unemployment rate (unem) might have a positive effect on individuals wishing to leave not only the service but the nursing profession as well. While our results showed this to be significant in every regression, the sign of the coefficient was the opposite of that which was expected. Possible reasons for this are unclear as the variable is apparently capturing some other facet of the data. To understand the exact nature of the relationship will require a more in-depth study of the data. This is outside our current study.

2. Model Fit

The parameters for a "good fit" as measured by the R^2 are a little broader in an econometric model such as ours, than in a scientific study for example. For example, in a Logistic regression, the type of regression used in this study, the response is limited to only two possibilities. To adjust for this, the Max–rescaled R–Square is reported. This measure divides the original R^2 by its upper bound and provides a better measure than the R^2.

In the regressions run with leave as the dependant variable the Max-rescaled R-Square ranged from 45 percent to 83 percent. Overall, these are accepTable values for the type of data being analyzed. In the Test for the Global Null Hypothesis where BETA = 0, the p value in each of the leave regressions was <.0001. We reject the null hypothesis that BETA = 0 and conclude that the BETAs do have an effect on the dependant variable, leave.

In the regressions run with promote as the dependant variable the Max-rescaled R-Square ranged from 6 percent to 50 percent. In the Test for the Global Null Hypothesis where BETA = 0, the p value in each of the promote regressions was <.0001. We reject the null hypothesis that BETA = 0 and conclude that the BETAs do have and

effect on the dependant variable, promote. In addition to descriptive statistics, Appendix G contains the results of all the regressions for Leaving and Promoting, lists predictive accuracy obtained from Classification Tables, R-square, and Max-rescaled R-Square calculations.

3. Conclusions from the Regression Analysis

Accession source was found to be a significant factor in all regressions regarding leaving and in nine out of ten regressions pertaining to promotion. Given that accession source was found to be significant, the Markov model formulation was adjusted to allow for different promotion and leaving rates based on accession source for the rank/year in service combinations where the regression demonstrated significance.

Additional variables found to demonstrate a high frequency of significance included gender, number of dependants and marital status. By utilizing the other significant variables as controls, we are able to assess a truer picture of accession source significance. Additionally, based on current demographic data, we can assume that these exogenous variables will remain relatively constant over the time horizon under consideration.

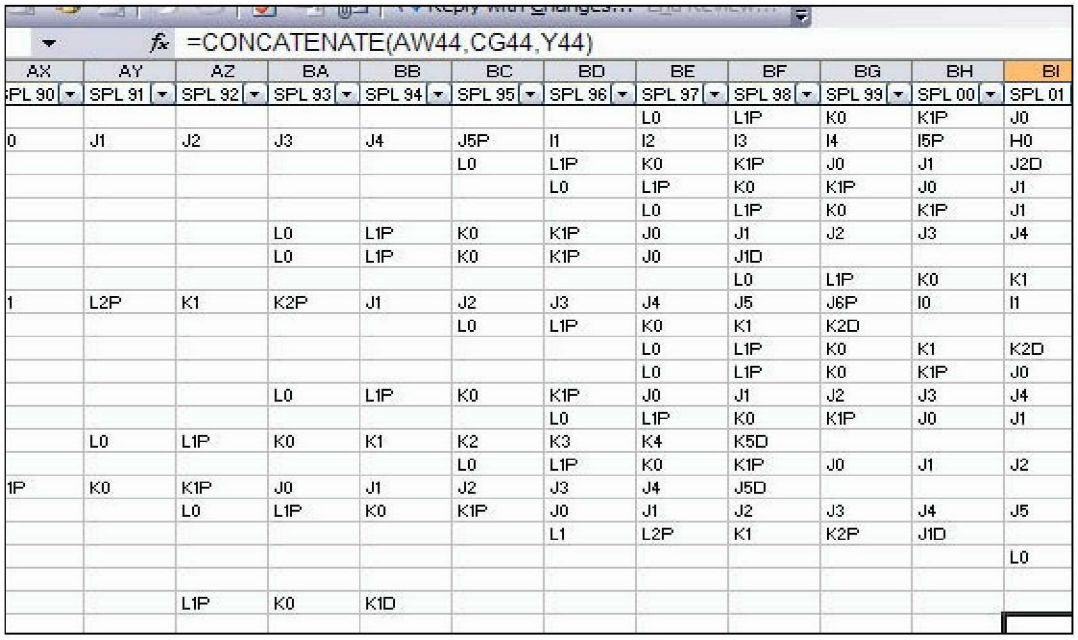
G. MARKOV MODEL CREATION

Our sample population included accession sources from BDCP, Direct Accession, MECP, NCP, Recall and FTOST. Presently the Nurse Corps no longer utilizes BDCP, discontinued in 1992, or FTOST, discontinued in 1993. The Nurse Corps does offer STA-21 as discussed in section IIB. To account for expected variability within these accession sources, eight different Markov models were created, one for each accession source and one for all accession sources combined. Microsoft Excel was used to formulate the Markov Models.

1. Creation of Markov Chains, All Accession Sources Combined

Initially, within the sample population, individuals were identified by rank and career status (the number of years at rank, year promoted out of rank, or year discharged from the Navy). This was done by using the "CONCATENATE" function in Excel. By combining rank, years in rank, promotion status, and discharge status, a new variable was

created that would help determine the number of promotions and discharges for specific ranks and years (Chart 2). From this, the percentage of people staying, promoting, and leaving from each rank and year were calculated. Chart 3 demonstrates the percentage of promotions and discharges for all accession sources combined. These percentages were then placed into a general Markov Model which included all accession sources.



=CONCATENATE(AW44,CG44,Y44)

AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
SPL 90	SPL 91	SPL 92	SPL 93	SPL 94	SPL 95	SPL 96	SPL 97	SPL 98	SPL 99	SPL 00	SPL 01
							L0	L1P	K0	K1P	J0
0	J1	J2	J3	J4	J5P	I1	I2	I3	I4	I5P	H0
					L0	L1P	K0	K1P	J0	J1	J2D
						L0	L1P	K0	K1P	J0	J1
							L0	L1P	K0	K1P	J1
			L0	L1P	K0	K1P	J0	J1	J2	J3	J4
			L0	L1P	K0	K1P	J0	J1D			
								L0	L1P	K0	K1
1	L2P	K1	K2P	J1	J2	J3	J4	J5	J6P	I0	I1
					L0	L1P	K0	K1	K2D		
							L0	L1P	K0	K1	K2D
							L0	L1P	K0	K1P	J0
			L0	L1P	K0	K1P	J0	J1	J2	J3	J4
						L0	L1P	K0	K1P	J0	J1
	L0	L1P	K0	K1	K2	K3	K4	K5D			
					L0	L1P	K0	K1P	J0	J1	J2
1P	K0	K1P	J0	J1	J2	J3	J4	J5D			
		L0	L1P	K0	K1P	J0	J1	J2	J3	J4	J5
						L1	L2P	K1	K2P	J1D	
											L0
		L1P	K0	K1D							

Chart 2. Screen shot of Partial CONCATENATE Function

	# Staying	# Promote	# Leaving	# Total	% Stay	% Prom	% Leaving
L0	2344	38	1	2383	98%	2%	0%
L1	641	2126	10	2777	23%	77%	0%
L2	20	481	48	549	4%	88%	9%
L3	5	3	10	18	28%	17%	56%
L4	3	2	0	5	60%	40%	0%
L5	1	0	1	2	50%	0%	50%
K0	2187	9	17	2213	99%	0%	1%
K1	922	1648	58	2628	35%	63%	2%
K2	100	504	236	840	12%	60%	28%
K3	9	24	47	80	11%	30%	59%
K4	3	5	2	10	30%	50%	20%
K5	0	1	2	3	0%	33%	67%
J0	1795	1	186	1982	91%	0%	9%
J1	1660	0	224	1884	88%	0%	12%
J2	1360	0	151	1511	90%	0%	10%
J3	1026	6	126	1158	89%	1%	11%
J4	748	30	88	866	86%	3%	10%
J5	313	233	49	595	53%	39%	8%
J6	94	40	22	156	60%	26%	14%
J7	19	2	38	59	32%	3%	64%
J8	5	0	5	10	50%	0%	50%
I0	290	0	4	294	99%	0%	1%
I1	225	0	5	230	98%	0%	2%
I2	139	0	7	146	95%	0%	5%
I3	117	1	6	124	94%	1%	5%
I4	82	7	5	94	87%	7%	5%
I5	47	6	5	58	81%	10%	9%
I6	16	2	7	25	64%	8%	28%
I7	5	0	0	5	100%	0%	0%
I8	4	0	0	4	100%	0%	0%
H0	15	0	0	15	100%	0%	0%
H1	9	0	0	9	100%	0%	0%
H2	6	0	0	6	100%	0%	0%
H3	3	0	0	3	100%	0%	0%
H4	1	0	0	1	100%	0%	0%

1										
2	Initial Matrix									
3		**L0**	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**K0**	**K1**	**K**
4	**L0**		0.98						0.02		
5	**L1**			0.23					0.77		
6	**L2**				0.04				0.88		
7	**L3**					0.28			0.1		
8	**L4**						0.60		0.40		
9	**L5**							0.50			
10	**L6**								0.00		
11	**K0**									0.99	
12	**K1**										0.3
13	**K2**										

Chart 3. Screen shot New Variable formulation in Excel and Corresponding Matrix Development

2. Creation of Markov Chains Specific to Each Accession Source

To account for variation at statistically significant carrier points, seven additional Markov models, one for each accession source, were created using the same process described above. The baseline transition probabilities identified in the general model were modified using the results of the logistic regression to reflect the impact of accession source. For "years in rank" not deemed significant, the percentages found in the "overall matrix" were used. For "years in rank" deemed significant by the previous regressions, the percentages specific to that accession source were used (Appendix F). These probabilities then populated the appropriate matrix.

3. Determining the Requirements to Determine Yearly Change; Recruit Input and Base Year Distribution of Rank

In creating a prediction for future years totals, the following Excel formula was used "=MMULT(TRANSPOSE(the matrix),last years totals) + the number of new recruits * the distribution of the recruits". Thus, in addition to knowing the Markov Chains, it is required that we know the rank distribution of new recruits for each accession source and the number of individuals present within each accession at the base year, time "0".

a. Appropriate Rank Distribution of New Recruits Entering the System

By combining information from the database for fiscal years 1997-2001 and recommendations from the Nurse Corps Community Manager, we were able to approximate the rank distribution of new recruits by accession source. Table 4 delineates these results:

	ROTC	MECP	NCP	FTOST	Direct (no bonus)	Direct (with bonus)	Recall
ENS	100.00%	24.00%	100.00%	24.00%	100.00%	100.00%	13%
LTJG		51.00%		51.00%			24%
LT		25.00%		25.00%			57%
LCDR		0.00%		0.00%			6%

Table 4. Rank Distribution of Accession Sources (1997-2001)

b. Determining the Appropriate Number of Individuals Present within Each Accession at the Base Year, Time "0"

To determine the yearly change for year 1, the appropriate distribution of personnel to both accession source and time in rank the starting year (year 0) was required. However, this information was not directly available, requiring an approximation based on the average distributions within the last 5 years of our sample population (1997-2001) and the known total numbers of individuals currently in each rank.

First, since the known accession source for each rank may not be available for the base year, it was required that we allocated the ranks through each accession source. This was done by examining the historical data in our combined database for fiscal years 1997-2001. The average distribution of rank for each accession source is listed below in Table 5.

ENS: 35% ROTC, 6% Direct (No Bonus), 13% Direct (with Bonus), 22% MECP, 23% NCP, 0% FTOST 0% Recall
LTJG: 30% ROTC, 6% Direct (No Bonus), 26% Direct (with Bonus), 19% MECP, 18% NCP, 0% FTOST 1% Recall
LT : 12% ROTC, 9% Direct (No Bonus), 33% Direct (with Bonus), 30% MECP, 10% NCP, 2% FTOST 3% Recall
LCDR: 0% ROTC, 11% Direct (No Bonus), 36% Direct (with Bonus), 6% MECP, 0% NCP, 8% FTOST 39% Recall

Table 5. Distribution of Accession Sources by Rank (1997-2001)

	ROTC Total	Direct No	Direct With	MECP	NCP	FTOST	Recall
	Average 97-01	Average 97-01	Average 97-01	Average 97-01	Average 97-01	Average 97-01	Average 97-01
L0	42.0%	24.6%	34.8%	44.5%	43.7%	0.0%	0.0%
L1	52.0%	43.8%	42.7%	46.8%	45.2%	0.0%	0.0%
L2	4.9%	31.6%	21.5%	8.6%	11.1%	0.0%	0.0%
L3	0.4%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%
L4	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
L5	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
L6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
K0	49.4%	43.0%	27.8%	41.2%	38.8%	0.0%	35.7%
K1	44.5%	39.9%	42.7%	49.5%	46.7%	0.0%	53.7%
K2	6.1%	15.7%	26.8%	9.1%	12.9%	0.0%	4.0%
K3	0.0%	1.4%	1.8%	0.2%	1.2%	0.0%	6.7%
K4	0.0%	0.0%	0.4%	0.0%	0.4%	0.0%	0.0%
K5	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%
J0	53.0%	10.7%	14.1%	22.9%	54.2%	2.1%	7.3%
J1	27.9%	14.9%	20.6%	22.6%	28.3%	4.0%	8.1%
J2	12.5%	15.5%	19.0%	18.9%	11.6%	8.9%	10.6%
J3	4.4%	14.8%	15.1%	17.0%	4.2%	20.2%	13.5%
J4	1.4%	16.5%	13.4%	13.7%	1.7%	34.0%	15.3%
J5	0.8%	14.7%	11.7%	5.0%	0.0%	19.9%	16.6%
J6	0.0%	6.7%	4.7%	0.0%	0.0%	10.0%	14.9%
J7	0.0%	5.4%	1.3%	0.0%	0.0%	0.8%	10.1%
J8	0.0%	0.8%	0.2%	0.0%	0.0%	0.0%	3.6%
J9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.8%
I0	0.0%	28.6%	33.3%	60.4%	0.0%	30.3%	12.7%
I1	0.0%	21.3%	29.2%	27.4%	0.0%	25.5%	20.3%
I2	0.0%	16.4%	15.2%	5.3%	0.0%	19.6%	19.5%
I3	0.0%	14.7%	16.2%	6.9%	0.0%	13.8%	18.5%
I4	0.0%	13.5%	6.0%	0.0%	0.0%	8.4%	13.8%
I5	0.0%	5.4%	0.0%	0.0%	0.0%	2.5%	8.0%
I6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
H0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
H1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
H2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
H3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
H4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 6. Distribution of Years in Rank by Accession Source (1997-2001)

In addition to the average distribution by accession source, a distribution by years in rank was required for year 0. This was computed using the average from 1997-2001 (Table 6). In order to obtain an approximation of "year 0", these percentages would then be multiplied by the known total of individuals in each rank. Table 7 below gives an example of the calculations that will be discussed in the Results section.

Total Number of LTJGs	451.00			
% of LTJGs that are ROTC	30%			
Number of ROTC LTJG	135.48			
		Distribution of years in rank	Number of LTJGs at time 0 that are in ROTC	
		49.4%	66.92	LTJGs in first year
		44.5%	60.23	LTJGs in second year
		6.1%	8.33	LTJGs in third year
135.48 ROTC LTJGs multiplied by		0.0%	0.00	LTJGs in fourth year

Table 7. Calculating Distribution of Years in Rank by Accession Source, given a known number of accessions (1997-2001)

4. Model Output Combining Calculations into One Output

After the yearly segregated flow of individuals were calculated, a recombined yearly state for the Nurse Corps from Ensign to Lieutenant Commander was computed. This was done by adding the individual flow results from the separate Markov Models and combining them into one result.

V. RESULTS OF MARKOV MODEL

A. MODEL VALIDATION

Model accuracy was accessed using FY01-FY04 information provided by the Nurse Corps Community Managers office. The Nurse Corps Community Manager also provided accession rates by source and year. The model was then run and predicted values were compared to the actual NC data; over the three years, 2002-2004, the model over predicted by 1.2 percent. This was calculated as follows: {(predicted-actual)/actual}*100= X. $(2002_x + 2003_x + 2004_x) / 3$= Y. See Table 8 below.

Paygrade	NC Data End Strength (2001)	Predicted End Strength (2002)	NC Data End Strength (2002)	Difference
ENS	440	431	437	-6
LTJG	444	480	446	+34
LT	1185	1177	1160	+17
LCDR	597	594	606	-12
Total	2666	2682	2649	+33
{(2682-2649)/2649}*100= 1.2			Over predicted 2002 End Strength by 1.2 %	
Paygrade	NC Data End Strength (2002)	Predicted End Strength (2003)	NC Data End Strength (2003)	Difference
ENS	437	403	392	+11
LTJG	446	483	483	+0
LT	1160	1154	1163	-9
LCDR	606	601	609	-8
Total	2649	2641	2649	-8
{(2641-2649)/2649}*100= .3			Under predicted 2003 End Strength by .3 %	
Paygrade	NC Data End Strength (2003)	Predicted End Strength (2004)	NC Data End Strength (2004)	Difference
ENS	392	377	396	-19
LTJG	483	495	476	+19
LT	1163	1184	1091	+93
LCDR	609	604	629	-25
Total	2649	2660	2592	+68
{(2660- 2592)/2592}*100= 2.6			Over predicted 2004 End Strength by 2.6 %	

Table 8. Validation Table

1. Recruit Inputs during Model Validation

As discussed in section G3, in addition to knowing the Markov chains, it is required that we know the distribution of new recruits throughout each accession source. This distribution was provided by the Nurse Community Manager's Office and is in Table 9 below. The number of recruits by accession sources was then combined with the rank allocation by accession source as discussed in section G3a (Table 10), resulting in the number of recruits by rank for each year (Table 11).

	FY02	FY03	FY04
Gains			
DIRECT^	76	67	53
RECALL	15	5	20
NROTC	52	44	38
NCP	62	50	62
MECP	41	52	66
STA 21	0	0	1
FTOST	0	0	0
Total Gains:	246	218	240

Table 9. Number of Recruits for FY01-FY04

	ROTC	MECP	NCP	FTOST	Direct (no bonus)	Direct (with bonus)	Recall
ENS	100.00%	24.00%	100.00%	24.00%	100.00%	100.00%	13%
LTJG		51.00%		51.00%			24%
LT		25.00%		25.00%			57%
LCDR		0.00%		0.00%			6%

Table 10. Rank Distribution of Accession Sources

	FY02		FY03		FY04	
	# of Individuals	Rank Distribution	# of Individuals	Rank Distribution	# of Individuals	Rank Distribution
DIRECT*	76		67		53	
ENS		76		67		53
LTJG		0		0		0
LT		0		0		0
LCDR		0		0		0
RECALL	15		5		20	
ENS		1.95		0.65		2.6
LTJG		3.6		1.2		4.8
LT		8.55		2.85		11.4
LCDR		0.9		0.3		1.2
NROTC	52		44		38	
ENS		52		44		38
LTJG		0		0		0
LT		0		0		0
LCDR		0		0		0
NCP	62		50		62	
ENS		62		50		62
LTJG		0		0		0
LT		0		0		0
LCDR		0		0		0
MECP	41		52		66	
ENS		9.84		12.48		15.84
LTJG		20.91		26.52		33.66
LT		10.25		13		16.5
LCDR		0		0		0
STA 21	0		0		1	
ENS		0		0		0.24
LTJG		0		0		0.51
LT		0		0		0.25
LCDR		0		0		0
FTOST	0		0		0	
Total Gains:	246		218		240	

Table 11. Number of New Recruits for FY 02-FY04

2. Base Year Settings during Model Validation

The distribution of the base year for each of the calculations in the validation process was determined by using the numbers provided by the Nurse Corps and distributing them across the accession sources as discussed in section G3b. The numbers of individuals in each rank were disseminated throughout the seven accession sources (Table 12). This resulted in three individual base years: 2001, 2002, and 2003 (Table 13).

ENS: 35% ROTC, 6% Direct (No Bonus), 13% Direct (with Bonus), 22% MECP, 23% NCP, 0% FTOST 0% Recall
LTJG: 30% ROTC, 6% Direct (No Bonus), 26% Direct (with Bonus), 19% MECP, 18% NCP, 0% FTOST 1% Recall
LT : 12% ROTC, 9% Direct (No Bonus), 33% Direct (with Bonus), 30% MECP, 10% NCP, 2% FTOST 3% Recall
LCDR: 0% ROTC, 11% Direct (No Bonus), 36% Direct (with Bonus), 6% MECP, 0% NCP, 8% FTOST 39% Recall

Table 12. Distribution of Accession Sources by Rank (1997-2001)

	Total #	DIRECT (no bonus)	DIRECT (with bonus	RECALL	NROTC	NCP	MECP	STA 21	FTOST	
2001										
ENS	440	6%	13%	0%	35%	23%	22%	0%	0%	
Sub-total		*26*	*57*	*0*	*154*	*101*	*97*	*0*	*0*	
LTJG	444	6%	26%	1%	30%	18%	19%	0%	0%	
Sub-total		*27*	*115*	*4*	*133*	*80*	*84*	*0*	*0*	
LT	1185	9%	33%	3%	12%	10%	30%	0%	2%	
Sub-total		*107*	*391*	*36*	*142*	*119*	*356*	*0*	*24*	
LCDR	597	11%	36%	39%	0%	0%	6%	0%	8%	
Sub-total		*66*	*215*	*233*	*0*	*0*	*36*	*0*	*48*	
2002										
ENS	437	6%	13%	0%	35%	23%	22%	0%	0%	
Sub-total		*26*	*57*	*0*	*153*	*101*	*96*	*0*	*0*	
LTJG	446	6%	26%	1%	30%	18%	19%	0%	0%	
Sub-total		*27*	*116*	*4*	*134*	*80*	*85*	*0*	*0*	
LT	1160	9%	33%	3%	12%	10%	30%	0%	2%	
Sub-total		*104*	*383*	*35*	*139*	*116*	*348*	*0*	*23*	
LCDR	606	11%	36%	39%	0%	0%	6%	0%	8%	
Sub-total		*67*	*218*	*236*	*0*	*0*	*36*	*0*	*48*	
2003										
ENS	392	6%	13%	0%	35%	23%	22%	0%	0%	
Sub-total		*24*	*51*	*0*	*137*	*90*	*86*	*0*	*0*	
LTJG	483	6%	26%	1%	30%	18%	19%	0%	0%	
Sub-total		*29*	*126*	*5*	*145*	*87*	*92*	*0*	*0*	
LT	1163	9%	33%	3%	12%	10%	30%	0%	2%	
Sub-total		*105*	*384*	*35*	*140*	*116*	*349*	*0*	*23*	
LCDR	609	11%	36%	39%	0%	0%	6%	0%	8%	
Sub-total		*67*	*219*	*238*	*0*	*0*	*37*	*0*	*49*	

Table 13. Number of Individuals by Rank and Accession at Time "0" (base year) for 2001-2003

B. IDENTIFY OVERAGES AND UNDERAGES, 2006-2009

BUMED supplied target end strength numbers for 2005, 2006, 2007, 2008, and 2009. The total end-strength for ENS through LCDR were 2587 in 2005, 2560 in 2006, 25456 in 2007, 2531 in 2008, and 2515 in 2009. Rank breakdown is shown in Table 14.

Rank Breakdown	2005	2006	2007	2008	2009
ENS	368	339	316	298	275
LTJG	568	571	574	573	577
LT	1018	977	996	987	991
LCDR	633	673	659	673	673
Total	2587	2560	2545	2531	2516

Table 14. Nurse Corps End Strength Targets for 2005-2009

1. Identifying Pre-existing Overages, 2006-2009

In an attempt to witness any naturally occurring overages, the degree that the expected value is greater than the target, 2005 end-strength was used as the base year (time 0) and incoming recruits were not allowed to enter the system for the remaining four years. The resulting end-strengths for fiscal years 2006 – 2009 were compared to the targeted end-strengths. This resulted in an overage of 91 LTs after 1 year. By the fourth year, end-strength for fiscal year 2009, this overage was eliminated through attrition (Table 15). LT is the only rank to experience overages without adding new recruits to the system.

Resulting Overage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4		
ENS	0.00	0.00	0.00	0.00		
LTjg	0.00	0.00	0.00	0.00		
LT	91.44	78.76	41.25	0.00		
LCDR	0.00	0.00	0.00	0.00		
Total	91.44	78.76	41.25	0.00	Overage Sub Total	211.45

Table 15. Resulting Overage differences from Nurse Corps End Strength Targets for 2006-2009, no new recruits added to the system.

2. Identifying Underages, 2006-2009

To determine any potential underages for 2006-2009, the degree that the expected value is smaller than the target, an average of the currently planned accession rates were used. They are as follows: MECP was 46, ROTC was 47, NCP was 55, Recall was 15, Direct Accession 75, FTOST was 0, and Sta-21 was 12. This totaled 250 recruits (Table 16).

	FY05	FY06	FY07	FY08	FY09		Average
DIRECT^	80	84	72	72	72		75
RECALL	15	15	15	15	15		15
NROTC	50	42	48	48	48		47
NCP	39	55	55	55	55		55
MECP	54	35	50	50	50		46
STA 21	12	19	10	10	10		12
	250	250	250	250	250		250

Table 16. Planned Accessions for the Nurse Corps for 2005-2009

Using the above accession rates, the greatest underage was seen in the ranks of LTJG, reaching a shortage of 110 individuals by the third year. A slight increase in underage was expected for LTJG due to increases in targets, 568 in year 1 to 577 in year four (difference of 9) with no change in the rate of accessions. However, underage calculations show a difference between year one and year three of 66 individuals. Table 17 below provides a screen shot of these calculations.

Resulting Underage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4
ENS	0.00	0.00	0.00	0.00
LTjg	44.84	100.89	110.75	89.05
LT	0.00	0.00	0.00	0.00
LCDR	51.85	26.42	38.56	41.53
Total	96.69	127.31	149.31	130.58

Underage Sub Tote 503.89

Total 1401.78

Table 17. Resulting Underage differences from Nurse Corps End Strength Targets for 2006-2009

C. MINIMIZING OVERAGE AND UNDERAGE THROUGH OPTIMIZATION

Currently the Nurse Corps plans to recruit 250 individuals for fiscal year 2006 in order to meet end strength targets of 339 ENSs, 571 LTJGs, 977 LTs, and 673 LCDRs for a total end strength of 2560 (these ranks only). In FY 2006 the distribution of these 250 accessions breaks down as follows: Direct Accession 84, Recall 15, ROTC 42, NCP 55, MECP 35, and STA-21 19.

According to our model, after one year, this plan will result in an overage of 40 ENSs and 116 LTs and an underage of 41 LTJGs and 52 LCDRs (Table 18). These results suggest that the Nurse Corps is willing to accept an underage of 92.6 individuals. If this pattern continues, our Markov Model predicts that they will miss their targets in

the following manner: an overage of ENSs and LTs totaling of 886 over a four year period and an underage of LTJGs and LCDRs totaling 484 over the same four year period.

Resulting Overage Between Target and Calculated

	Year 1	Year 2	Year 3	Year 4		
ENS	40.01	92.74	123.61	147.13		
LTjg	0.00	0.00	0.00	0.00		
LT	116.09	125.95	135.75	104.66		
LCDR	0.00	0.00	0.00	0.00		
Total	156.10	218.69	259.36	251.78	Overage Sub Total	885.93

Resulting Underage Between Target and Calculated

	Year 1	Year 2	Year 3	Year 4		
ENS	0.00	0.00	0.00	0.00		
LTjg	40.75	92.83	104.60	87.45		
LT	0.00	0.00	0.00	0.00		
LCDR	51.85	26.42	38.56	41.53		
Total	92.60	119.25	143.16	128.98	Underage Sub Total	483.99
					Total	1369.92

Table 18. Resulting Overages and Underages when comparing the Nurse Corps Current Accession plan and targets for 2006-2009

1. Discussion on Excel's Solver and Applied Constraints

Solver is part of a suite of commands in EXCEL sometimes called what-if analysis tools. With Solver, the optimal value for a formula in one cell, called the target cell, can be found. Solver works with a group of cells that are related, either directly or indirectly, to the formula in the target cell. Solver adjusts the values in the changing cells you specify, called the adjusTable cells, to produce the result you specify from the target

cell formula. You can apply constraints to restrict the values Solver can use in the model, and the constraints can refer to other cells that affect the target cell formula. Solver can be used to determine the maximum or minimum value of one cell by changing other cells.

Excel Solver was used to optimize accession sources and rank distribution in an attempt to minimize overages and underages. Solver was set for a precision of .001 and 5% tolerance. Linearity was not to be assumed because of the "if" statements used to form 'overage' and 'underage' calculations.

2. Minimizing Overage and Underage by Optimizing Accession Source

In an attempt to minimize the overages and underages described above at the beginning of section C, Solver was used to calculate the optimal mix of accession source, minimizing both overage and underage over the four year planning horizon.

Constraints were required for this calculation. Without constraints, Solver placed the recruits into accession sources without consideration for plausibility. Constraints were as follows: MECP must account for at least 21% of the new recruits, ROTC at least 19%, NPC at least 21%, Sta-21 at least 1%, Recall at least 5%, Direct Accession with bonus and without bonus must each account for 15% of new recruits, and FTOST will have no recruits. These constraints allowed for 3% flexibility from the current plan of accession rate. Additionally, total number of recruits was limited to 210 a year.

The number of individuals suggested by Solver in order to obtain an optimal mix was 38 MECP, 37 ROTC, 38 NCP, 0 FTOST, 27 Direct Accessions (both with bonus and without bonus), 4 Sta-21, and 9 Recall. The total number of recruits was expected to be 180. As seen above, LTs again experienced the greatest degree of overage, 108 by year 2, and the LTJGs experienced the greatest degree of underage, 197 by year four. See Table 19 below.

Resulting Overage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4	
ENS	0.00	0.40	19.35	42.37	
LTjg	0.00	0.00	0.00	0.00	
LT	106.82	108.20	100.48	50.79	
LCDR	0.00	0.00	0.00	0.00	
Total	106.82	108.60	119.83	93.16	Overage Sub Total 428.40

Resulting Underage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4	
ENS	6.63	0.00	0.00	0.00	
LTjg	54.45	121.09	170.83	197.98	
LT	0.00	0.00	0.00	0.00	
LCDR	52.21	27.14	39.63	42.93	
Total	113.29	148.23	210.46	240.91	Underage Sub Total 712.89
					Total 1141.29

Table 19. Resulting Overage and Underage differences from Nurse Corps End Strength Targets for 2006-2009

3. Minimizing Overage and Underage by Simultaneously Optimizing the Rank Distribution and Accession Source

In addition to changing the number of individuals coming into each accession source, Solver was allowed to change the distribution of each new recruits rank. The previous constraints were maintained as above. In addition, ROTC and MECP were limited to ENSs only while NCP, Direct Accessions, and Sta-21 were allowed to bring in ENS and LTJGs. Recall was the only accession source allowed to bring in LCDRs.

The optimal accession mix, as calculated by Solver, required 210 individuals. In an attempt to make up for the underage seen in LTJG, previous section, Solver brought in 12 LCDRs through Recall and 32 LTJGs through Direct Accession. The percentage of the distribution is in Table 20 below. By allowing Solver to manipulate rank distributions, the resulting differences between target strengths and calculated strengths was improved by 521 individuals over the four year period. Table 21 below shows the overages and underages resulting from this solution.

Accession Source	Rank	% of Total From Accession Source
MECP	ENS	100%
Number of individuals: 45	LTJG	0%
% of totals: 21.43	LT	0%
	LCDR	0%
ROTC	ENS	100%
Number of individuals: 40	LTJG	0%
% of totals: 19.05	LT	0%
	LCDR	0%
NCP	ENS	96%
Number of individuals: 44	LTJG	4%
% of totals: 20.95	LT	0%
	LCDR	0%
Direct Accession (no bonus)	ENS	0%
Number of individuals: 32	LTJG	100%
% of totals: 15.42	LT	0%
	LCDR	0%
Direct Accession (with bonus)	ENS	.02%
Number of individuals: 32	LTJG	99.98%
% of totals: 15.24	LT	0%
	LCDR	0%
Sta-21	ENS	100%
Number of individuals: 2	LTJG	0%
% of totals: .95	LT	0%
	LCDR	0%
Recall	ENS	0%
Number of individuals: 15	LTJG	22.68%
% of totals: 7.14	LT	0%
	LCDR	77.32%

Table 20. Optimize Rank Distribution to Minimize Overage and Underage from Nurse Corps End Strength Targets for 2006-2009

Resulting Overage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4	
ENS	0.00	0.00	0.00	13.61	
LTjg	0.00	0.00	0.00	0.00	
LT	91.44	78.77	79.65	51.32	
LCDR	0.00	0.00	0.00	0.00	
Total	91.44	78.77	79.65	64.92	Overage Sub Total 314.77

Resulting Underage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4	
ENS	17.80	21.72	9.16	0.00	
LTjg	8.92	30.72	64.76	99.35	
LT	0.00	0.00	0.00	0.00	
LCDR	41.15	5.13	6.89	0.00	
Total	67.87	57.56	80.81	99.35	Underage Sub Total 305.60
					Total 620.38

Table 21. Resulting Overages and Underages after Optimizing Rank Distribution and Accession Source, Nurse Corps End Strength for 2006-2009

D. MINIMIZING OVERAGE AND UNDERAGE THROUGH OPTIMIZATION, CONSTRAINTS RELAXED TO 10% FLEXIBILITY

Previous constraints had 3% flexibility. However, this does not allow for much variation within Solver calculations, prompting a series of additional optimization calculations with constraint flexibility of 10%. For these calculations, constraints on the percentage (of the total number of accessions) of individuals per accession source were as follows: MECP 13% or more, ROTC 15% or more, NCP 21% or more, Direct Accessions (with and without bonus) 15% or more, STA-21 6% or more and Recall 5% or more.

1. Optimize Accession Distribution for FY 2006-2009

Attempting to minimize the overages and underages for FY2006-2009 while constraining the FY 2006 underage to 92.6 or less, the assumed tolerance level for underage after one year as determined above, we were required to access 238 individuals. Our model optimized distribution in the following manner: 53 MECP, 36 ROTC, 50 NCP, 36 Direct Accession, 15 STA-21, and 12 Recalls. The resulting overages and underages are in the screen shot below (Table 22).

Maintaining a consistent recruitment goal across a four year period, it appears that the current Nurse Corps plan is close to an optimum. Over the four year period, the difference between the planned discrepancy (1369) and the Solver discrepancy (1310) is relatively small. Our model does suggest a smaller amount of overages and a larger amount of underages, a proposal that may not be possible per current policy.

Resulting Overage Between Target and Calculated

	Year 1	Year 2	Year 3	Year 4	
ENS	29.11	71.16	100.50	123.93	
LTjg	0.00	0.00	0.00	0.00	
LT	114.87	123.62	132.89	101.09	
LCDR	0.00	0.00	0.00	0.00	
Total	143.98	194.77	233.39	225.02	Overage Sub Total 797.16

Resulting Underage Between Target and Calculated

	Year 1	Year 2	Year 3	Year 4	
ENS	0.00	0.00	0.00	0.00	
LTjg	40.45	92.45	113.75	106.85	
LT	0.00	0.00	0.00	0.00	
LCDR	52.03	26.78	39.10	42.23	
Total	92.48	119.23	152.85	149.08	Underage Sub Total 513.63
					Total 1310.78

Table 22. Resulting Overages and Underages when requiring underage for year 1 to be 92.6 or less

2. Optimizing Accession Distribution, Allowing Accession Rates to Change Every Year

The previous calculations where conducted on a 4 year fixed accession rate. However, the nurse corps is able to change accession rates from year to year. Because of this, an additional optimization was conducted allowing for yearly changes in accession rates over a four-year period.

a. Underages Maintained at 93 or Less

For each year, underage was not allowed to exceed 93 and the number of recruits where not allowed to exceed 400. All other constraints were applied as above for each year. The planned accession numbers were obtained from the Nurse Corps Community Manager and placed into the model. The optimized distributions of

accession sources, obtained from Solver, compared to planned distribution, can be seen in Table 23. The resulting overages and underages for both optimized distributions and planned distribution can be seen in Table 24.

The results demonstrated a small re-distribution of accession sources and larger number of recruits. In accessions there is a slightly larger reliance on MECP and slightly less reliance on ROTC. The most noTable difference is the number of recruits being accessed every year, 360 for the model and 250 for the Nurse Corps. The Nurse Corps has not recruited more than 300 individuals in a single year since 1995, when they brought in 399 accessions. This leads us to believe that the Nurse Corps is willing to accept underages of more that 93 individuals.

		Year 1				Year 2			
		Cal		Plan		Cal		Plan	
MECP		53	23%	35	14%	83	23%	50	20%
ROTC		35	15%	42	17%	54	15%	48	19%
NCP		49	21%	55	22%	76	21%	55	22%
FTOST		0	0%	0	0%	0	0%	0	0%
Direct Acce (No Bonus)		35	15%	42	17%	54	15%	36	14%
Direct Acce (With Bonus)		35	15%	42	17%	54	15%	36	14%
STA-21		14	6%	19	8%	22	6%	10	4%
Recall		12	5%	15	6%	18	5%	15	6%
Total		233	100%	250	100%	361	100%	250	100%

		Year 3				Year 4			
		Cal		Plan		Cal		Plan	
MECP		83	23%	50	20%	80	23%	50	20%
ROTC		54	15%	48	19%	53	15%	48	19%
NCP		76	21%	55	22%	74	21%	55	22%
FTOST		0	0%	0	0%	0	0%	0	0%
Direct Acce (No Bonus)		54	15%	36	14%	53	15%	36	14%
Direct Acce (With Bonus)		54	15%	36	14%	53	15%	36	14%
STA-21		22	6%	10	4%	22	6%	10	4%
Recall		18	5%	15	6%	18	5%	15	6%
Total		361	100%	250	100%	353	100%	250	100%

Table 23. Comparison of Optimized and Nurse Corps Planned Distribution of Accessions when rates were allowed to change every year, requiring underage to be 93 or less

Resulting Overage Between Target and Calculated								
	Year 1		Year 2		Year 3		Year 4	
	Calculated	Planned	Calculated	Planned	Calculated	Planned	Calculated	Planned
ENS	25	49	140	65	206	137	196	128
LTjg	0	0	0	0	0	0	0	0
LT	114	113	155	142	212	199	244	232
LCDR	0	0	0	0	0	0	0	0
Total	139	162	295	207	418	336	440	360
Resulting Underage Between Target and Calculated								
	Year 1		Year 2		Year 3		Year 4	
	Calculated	Planned	Calculated	Planned	Calculated	Planned	Calculated	Planned
ENS	0	0	0	0	0	0	0	0
LTjg	41	46	47	76	5	28	23	45
LT	0	0	0	0	0	0	0	0
LCDR	52	51	46	46	65	65	70	70
Total	93	97	93	122	70	93	93	115
Grand Total	232	259	388	329	488	429	533	475
Overages and Underages								

Table 24. Comparison of Calculated and Nurse Corps Planned Overages and Underages when accession rates were allowed to change every year, requiring underage to be 93 or less

b. Number of Recruits Maintained at 250

Because the allowed underage, assumed to be 93 in previous calculations, did not appear to be accurate, we ran Solver using 250 recruits as a constraint over the four year period instead of the maximum underage of 93. 250 is the number of accession currently planned by the Nurse Corps. All other constraints were applied as previous for each year.

As above, the results show a re-distribution of accession sources with increased reliance on MECP. Overall the model solution improves the nuber of underages and overages by an average of 15 individuals each year. However, in years three and four the nurse corps planned underages are smaller because they are willing to accept greater overages during these years. Results can be seen in Tables 25 and 26 below.

		Year 1				Year 2			
		Calculated		Planned		Calculated		Planned	
MECP		55	22%	35	14%	55	22%	50	20%
ROTC		38	15%	42	17%	38	15%	48	19%
NCP		53	21%	55	22%	53	21%	55	22%
FTOST		0	0%	0	0%	0	0%	0	0%
Direct Acce (No Bonus)		38	15%	42	17%	38	15%	36	14%
Direct Acce (With Bonus)		38	15%	42	17%	38	15%	36	14%
STA-21		15	6%	19	8%	15	6%	10	4%
Recall		13	5%	15	6%	13	5%	15	6%
Total		250	100%	250	100%	250	100%	250	100%

		Year 3				Year 4			
		Calculated		Planned		Calculated		Planned	
MECP		55	22%	50	20%	55	22%	50	20%
ROTC		38	15%	48	19%	38	15%	48	19%
NCP		53	21%	55	22%	53	21%	55	22%
FTOST		0	0%	0	0%	0	0%	0	0%
Direct Acce (No Bonus)		38	15%	36	14%	38	15%	36	14%
Direct Acce (With Bonus)		38	15%	36	14%	38	15%	36	14%
STA-21		15	6%	10	4%	15	6%	10	4%
Recall		13	5%	15	6%	13	5%	15	6%
Total		250	100%	250	100%	250	100%	250	100%

Table 25. Comparison of Optimized and Nurse Corps Planned Distribution of Accessions when the number of recruits are held at 250

Resulting Overage Between Target and Calculated								
	Year 1		Year 2		Year 3		Year 4	
	Calculated	Planned	Calculated	Planned	Calculated	Planned	Calculated	Planned
ENS	39	49	67	65	87	137	112	128
LTjg	0	0	0	0	0	0	0	0
LT	116	113	145	142	188	199	209	232
LCDR	0	0	0	0	0	0	0	0
Total	155	162	212	207	275	336	321	360
Resulting Underage Between Target and Calculated								
	Year 1		Year 2		Year 3		Year 4	
	Calculated	Planned	Calculated	Planned	Calculated	Planned	Calculated	Planned
ENS	0	0	0	0	0	0	0	0
LTjg	39	46	58	76	64	28	71	45
LT	0	0	0	0	0	0	0	0
LCDR	52	51	46	46	66	65	71	70
Total	91	97	105	122	131	93	142	115
Grand Total	246	259	317	329	406	429	463	475
Overages and Underages								

Table 26. Comparison of Calculated and Nurse Corps Planned Overages and Underages when accession rates held at 250 each year

c. Changing the Distribution of Accession Sources and Simultaneously Optimizing the Distribution of Recruit Ranks

Attempting to minimize FY 2006 underage to 92.6 or less by redistributing accession sources and ranks of new recruits, we were required to access 233 individuals. Our model suggested the following 41 MECP, 35 ROTC, 50 NCP, 44 Direct Accession (with no bonus), 35 Direct Accessions (with bonus), 14 STA-21, and 14 Recalls. These numbers, and the resulting rank distributions (Table 27), provided the lowest amount of overage and underage (Table 28).

For these calculations, the following constraints were applied. The percentage of the total number of accessions of individuals per accession source were as follows: MECP 13% or more, ROTC 15% or more, NCP 21% or more, Direct Accessions (with and without bonus) 15% or more, STA-21 6% or more and Recall 5% or more. In addition, ROTC and MECP were limited to ENSs only while NCP, Direct Accessions, and Sta-21 were allowed to bring in ENS and LTJGs. Recall was the only accession source allowed to bring in LCDRs.

Accession Source	Rank	% of Total From Accession Source
MECP	ENS	92.55%
Number of individuals: 41	LTJG	7.45%
% of totals: 17.6	LT	0%
	LCDR	0%
ROTC	ENS	100%
Number of individuals: 35	LTJG	0%
% of totals: 15.02	LT	0%
	LCDR	0%
NCP	ENS	96.08%
Number of individuals: 50	LTJG	3.92%
% of totals: 21.46	LT	0%
	LCDR	0%
Direct Accession (no bonus)	ENS	0.06%
Number of individuals: 44	LTJG	99.94%
% of totals: 18.88	LT	0%
	LCDR	0%
Direct Accession (with bonus)	ENS	.22%
Number of individuals: 35	LTJG	99.78%
% of totals: 15.02	LT	0%
	LCDR	0%
Sta-21	ENS	96.71%
Number of individuals: 14	LTJG	3.29%
% of totals: 6.01	LT	0%
	LCDR	0%
Recall	ENS	0.07%
Number of individuals: 14	LTJG	1.11%
% of totals: 6.01	LT	0%
	LCDR	98.82%

Table 27. Resulting Distribution of Ranks among Accession Sources

Resulting Overage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4		
ENS	0.00	0.00	3.44	26.27		
LTjg	6.45	0.00	0.00	0.00		
LT	91.44	78.78	88.71	71.65		
LCDR	0.00	0.00	0.00	8.68		
Total	97.89	78.78	92.15	106.60	Overage Sub Total	375.43

Resulting Underage Between Target and Calculated Results

	Year 1	Year 2	Year 3	Year 4		
ENS	12.41	11.04	0.00	0.00		
LTjg	0.00	0.00	25.32	54.01		
LT	0.00	0.00	0.00	0.00		
LCDR	38.92	0.68	0.27	0.00		
Total	51.32	11.72	25.59	54.01	Underage Sub Total	142.65
	92.6				Total	518.07

Table 28. Resulting Overages and Underages after Optimizing Rank Distribution and Accession Source, Nurse Corps End Strength for 2006-2009

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VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS FROM MARKOV MODEL

The Markov Model demonstrated a pre-existing overage of lieutenants and an underage of LTJGs and LCDRs. It is possible that this difference is caused by quick promotion rates from LTJG to LT, causing a shortage of LTJGs, and insufficient promotions for lieutenants, leading to a regular underage of LCDRs. Promotion policies should be examined to compensate for this occurrence. Overage of LTs potentially could be redistributed to LTJG and LCDR by slowing the promotion to LT and increasing the promotion to LCDR. Any changes of this type would require policy review to determine associated costs, such as possible increased attrition of LTJGs.

The results of the Markov Model are difficult to assess without knowing the degree of overage and underage the Navy Nurse Corps is willing to accept. We were unable to obtain this information in time for the completion of this study. This limits our ability to provide a detailed, specific recommendation on the best mix of accession source and rank distributions to meet desired targets. Comparisons, however, between planned accessions and model optimization have demonstrated that for the immediate future, two years beyond present time zero, the Navy Nurse Corps is accessing recruits at a close to optimal mixture. In contrast, more distant future, four years beyond present time zero, do not appear to be optimized.

The results of the Markov Model optimization demonstrate that increased efficiency in manpower management can be obtained through redistribution of accession sources and ranks of new recruits. For example, not allowing for optimization in rank distribution resulted in a combined overage and underage total of 1401 (Appendix I). Allowing for optimization in rank distribution resulted in a combined overage and underage total of 518 (Appendix J). This demonstrates a substantial difference in results. These redistributions are strongly influenced by the constraints applied to Solver computations. Because of this, the accession distributions discussed in this paper may not yet be at optimal levels.

A shortcoming to the Solver program is its inability to process this model as a linear program. As discussed in section V-C-1, this is due in part to the "if" statements used to form the overage and underage calculations. A more robust linear program would eliminate this problem.

The optimal mix calculated by Solver is not a cost optimizing program. Actual cost expectations for each accession would provide a clearer picture of improved optimization through accession redistribution.

B. RECOMMENDATIONS AND CONSIDERATIONS FOR FUTURE STUDIES

Optimized models have demonstrated an increased reliance on MECP. Maeder (1999) found that MECP was the most cost effective accession source. Future studies should update these findings to determine if they are still valid for use before redistributing accession sources as recommended by our model.

The model suggests that a review of policy may be worthwhile in regards to rank distribution of accessions. The Markov model demonstrated improved efficiency by accessing individuals directly into the ranks of LTJG and LCDR. A study should be done to determine the pros and cons of directly accessing more senior individuals.

This Markov model utilizes static promotion rates based on historical trends. A model that would allow for changes in promotion rates would increase the models flexibility. The ability to change promotion rates for each rank provides the Nurse Corps with another force shaping tool.

This study was limited by the sample size, restricting us to ten regressions and a Markov model that only includes ENS-LCDR. Future studies would benefit from a larger sample population, including a broader range of ranks. This would allow for increased accuracy in predicting the effects of accession and a greater picture of end strength as it expands over the entire Nurse Corps.

C. SUMMARY

Our intent was to develop a Markov Model that would help determine the number of nurses the Navy must gain each year in order to maintain the desired end strength. Through multivariate analysis, significant characteristics affecting the career progression of individuals in the Navy Nurse Corps were identified. Our characteristic of primary concern, accession source, was determined to be of significant impact.

Eight Markov models were created, one for each accession source, and used to identify personnel flow from ENS through LCDR. These models were then combined into a single model. The models end-strength projections for 2006-2009 were then compared to the Nurse Corps targeted end-strengths for this same period. Several scenarios were run to minimize overages and underages in rank distribution. Optimization was achieved by changing both the distribution of accession sources and the distribution of recruited ranks.

Nurse Corps end-strength targets are only projections. Optimal distribution of both accession source and rank are dependant upon the degree of accepTable deviation from these targets. As stated above we were not able to acquire this information limiting our ability to accurately forecast optimized distribution of either accession source or rank.

The Markov Model has demonstrated that the Nurse Corps current business practices regarding accessions are at optimal levels for two year projections. However, the increasing variation between the current force structure plan and our models projections suggest that greater efficiency could be obtained in the out-years. This Markov Model provides a tool for improving extended forecasts.

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APPENDIX A – CURRENT ACCESSION TOOL "ONE PAGE WORLD BOOK"

Key: OPA = Officer Programmed Authorization. E/S = End Strength.

Data as of: 13-Aug-04 prepared by M131 — NURSE CORPS - One Page World Book

	FY92	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
Begin Strength:	3141	3301	3332	3223	3313	3266	3283	3189	3156	3132	3147	3157	**3108**	3060	3050	3040	3030	3020
Gains																		
DIRECT*	112	39	43	174	83	74	26	102	90	82	76	67	**53**	80	84	72	72	72
RECALL	9	9	1	15	13	11	5	15	19	13	15	5	**20**	15	15	15	15	15
NROTC	7	9	21	63	87	99	81	62	49	54	52	44	**38**	50	42	48	48	48
NCP		21	30	44	44	45	50	34	38	58	62	50	**62**	39	55	55	55	55
MECP	50	53	52	46	51	55	51	48	47	65	41	52	**66**	54	35	50	50	50
STA 21													**1**	12	19	10	10	10
HSCP	291	176	129	50	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0
FTOST	16	6	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0
FROM TNWO	1	3	0	6	16	19	10	6	1	0	0	0	**0**	0	0	0	0	0
IST		1	1	1					2		0	0	**0**	0	0	0	0	0
Other (PERS)								10	6	2	4	0	**2**	0	0	0	0	0
Total Gains:	**486**	**317**	**277**	**399**	**294**	**303**	**223**	**277**	**252**	**274**	**250**	**218**	**242**	**250**	**250**	**250**	**250**	**250**
Losses																		
RETIRE	106	119	191	137	119	90	101	96	96	88	87	130	**114**	92	92	92	92	92
RESIG	34	31	25	11	16	16	34	27	43	25	36	16	**23**	28	28	28	28	28
RAD	160	93	133	129	158	115	149	165	93	124	101	104	**128**	125	125	125	125	125
ADMIN DISCH	25	42	36	32	47	65	32	22	17	9	12	14	**17**	15	15	15	15	15
DEATH	1	1	1	0	1	0	1	0	0	1								
Other (PERS)									27	12	4	3	**8**	0	0	0	0	0
Total Losses:	**326**	**286**	**386**	**309**	**341**	**286**	**317**	**310**	**276**	**259**	**240**	**267**	**290**	**260**	**260**	**260**	**260**	**260**
Loss Rate	**10.38%**	**8.66%**	**11.58%**	**9.59%**	**10.29%**	**8.76%**	**9.66%**	**9.72%**	**8.75%**	**8.27%**	**7.63%**	**8.46%**	**9.33%**	**8.50%**	**8.52%**	**8.55%**	**8.58%**	**8.61%**
End Strength	**3301**	**3332**	**3223**	**3313**	**3266**	**3283**	**3189**	**3156**	**3132**	**3147**	**3157**	**3108**	**3060**	**3050**	**3040**	**3030**	**3020**	**3010**
Billets	3315	3270	3253	3232	3220	3202	3188	3130	3130	3132	3133	3136	**3136**	**3051**	**3046**	**3041**	**3036**	**3031**
+ 2XXX share		28	27	31	34	33	37	37	37	37	41	40	**40**	40	40	40	40	40
Total Billets		**3298**	**3280**	**3263**	**3254**	**3235**	**3225**	**3167**	**3167**	**3169**	**3174**	**3176**	**3176**	**3091**	**3086**	**3081**	**3076**	**3071**
+/- Billets		**34**	**-57**	**50**	**12**	**48**	**-36**	**-11**	**-35**	**-22**	**-17**	**-68**	**-116**	**-41**	**-46**	**-51**	**-56**	**-61**
E/S Target (OPA)*	**3314**	**3269**	**3249**	**3321**	**3267**	**3240**	**3204**	**3175**	**3164**	**3166**	**3173**	**3168**	**3170**	**3095**	**3090**	**3083**	**3081**	**3080**
+/- OPA	**-13**	**63**	**-26**	**-8**	**-1**	**43**	**-15**	**-19**	**-32**	**-19**	**-16**	**-60**	**-110**	**-45**	**-50**	**-53**	**-61**	**-70**

Gains & Losses in future months & years are "best-guess" estimates

*E/S Target for FY04 based on OPA SPRING 2004

*FY92-FY01 Gains/Losses/Strength does not match up with BUMIS; however kept data as is since has been used for decisions.

* Direct = both Direct Procurement & NAB

* Other (PERS)- for Gains and Losses includes Plan Adjusts and File Corrections

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APPENDIX B - COMBINING AND ELIMINATING VARIABLES

Combined Variables

Demographical variables
- Date of birth, Race, Gender, and Ethnic background 1990-2001

Career Track
- Accession source category 1990-2001
- Year group and fiscal year gain 1990-2001
- Expected Leave date for 1990-2001
- Active duty commissioning date 1990-2001

Education
- Highest Level of education for 1990-2001

Dropped Variables

Career Track
- Flight status 1990-2001
- Security classification 1990-2001
- Primary MOS 1990-2001
- Duty Location 1990-2001
- Projected rotation date 1991-2001

Education and enlisted training
- Certifications 1990-2001
- Composite score 4, 5, 6, 7, 8, 9, 10 for 1990-2001
- Training beginning and ending date 1990-2001
- Second highest education level 1990-2001
- Third highest education level 1990-2001
- Fourth highest education level 1990-2001
- Year individual received second highest education level 1990-2001
- Year individual received third highest education level 1990-2001
- Year individual received fourth highest education level 1990-2001

Language
- Language 1, 2, and 3 for 1990-2001

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APPENDIX C – UNEMPLOYMENT RATE, 1990-2001

1990 – National unemployment = 5.6
1991 – National unemployment = 6.9
1992 – National unemployment = 7.5
1993 – National unemployment = 6.9
1994 – National unemployment = 6.1
1995 – National unemployment = 5.6
1996 – National unemployment = 5.4
1997 – National unemployment = 4.9
1998 – National unemployment = 4.5
1999 – National unemployment = 4.2
2000 – National unemployment = 4.0
2001 – National unemployment = 4.8

http://stats.bls.gov/
Bureau of Labor and

Statistics

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APPENDIX D – INDEPENDENT VARIABLES

INDEPENDENT VARIABLE	DESCRIPTION
DirectNoBonus	Direct accession with no bonus
BDCP	Bachelors degree completion program
DirectBonus	Direct accession with a bonus
NCanProg	Nurse candidate program
FTOST	Full time out-service training
MECP	Medical enlisted commissioning program
Gender	Gender of individual
ActiveSpouse	Members spouse is active duty military
Master	Masters degree
Diploma	Completed diploma program in nursing
Assoc	Associates degree in nursing
critical	Critical care sub-specialty code
unem	Unemployment rate
dep	Dependants (yes or no)
marital	Marital status
Entry_Age	Age upon entering the service

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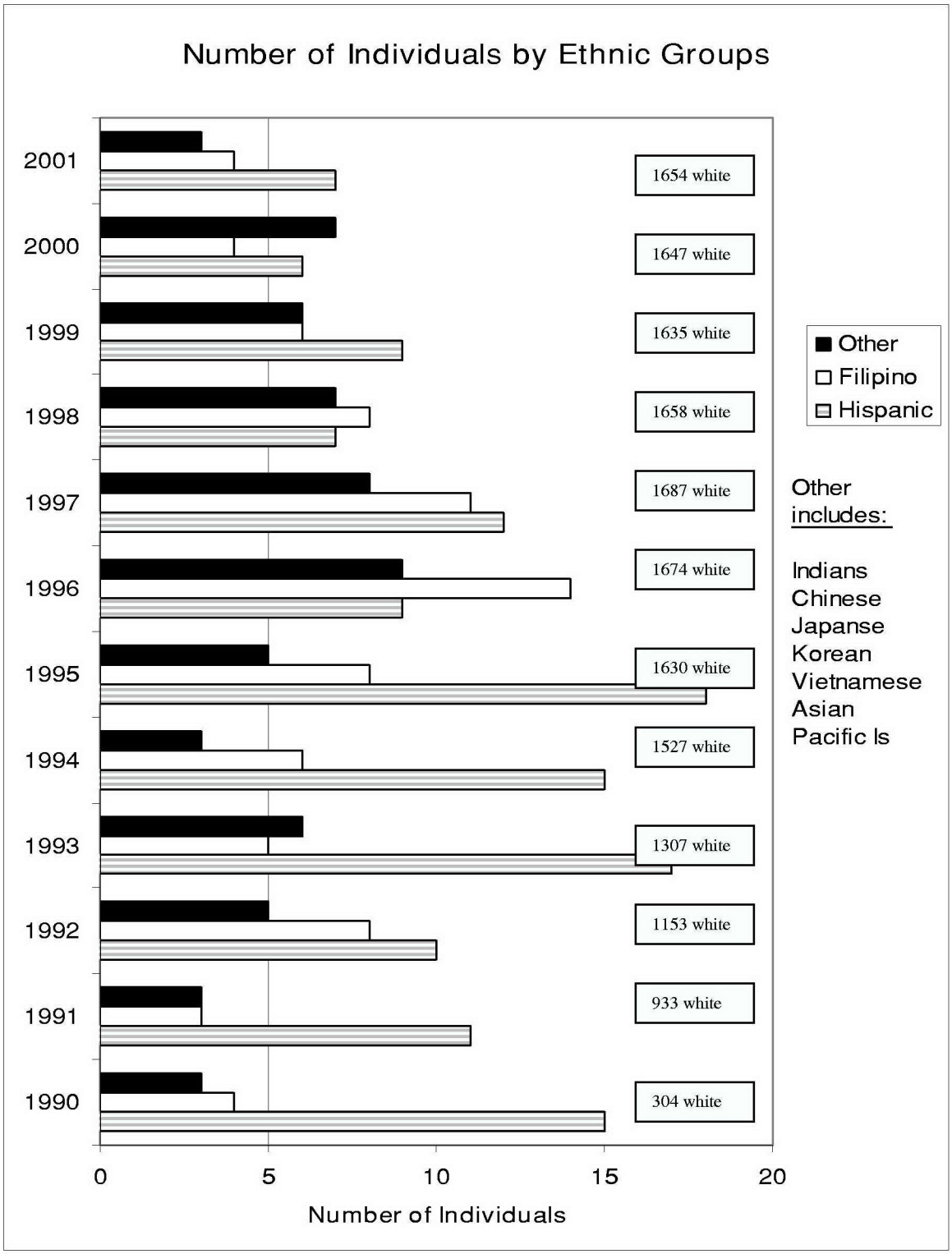
APPENDIX E - INDIVIDUALS BY ETHNIC GROUPS



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APPENDIX F - NUMBER OF INDIVIDUALS IN SAMPLE POPULATION, SHOWN BY YEAR AND ACCESSION SOURCE

Number of Individuals in the Sample Population by Year and Accession Source

Direct No Bonus

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	34	47	44	37	21	22	22	11	4	37	37	12
LTjg	15	27	57	57	47	37	24	23	25	17	15	44
LT	3	11	20	43	58	71	80	78	74	70	62	48
LCDR	0	0	0	0	4	4	6	13	13	12	17	26
CDR	0	0	0	0	0	0	0	0	0	3	3	3
Totals	52	85	121	137	130	134	132	125	116	139	134	133

Direct Bonus

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	114	172	112	55	44	165	181	85	40	9	40	49
LTjg	44	69	153	180	114	76	64	190	208	98	56	32
LT	7	30	66	104	201	217	228	199	196	298	270	249
LCDR	0	0	0	3	5	5	10	19	35	39	78	99
CDR	0	0	0	0	0	0	0	1	1	2	2	2
Totals	165	271	331	342	364	463	483	494	480	446	446	431

MECP Totals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	26	53	75	103	104	100	95	91	76	70	65	78
LTjg	0	0	26	50	72	99	105	99	96	88	76	68
LT	0	0	0	0	25	49	94	141	190	229	253	267
LCDR	0	0	0	0	0	0	0	0	1	3	14	29
CDR	0	0	0	0	0	0	0	0	0	0	0	0
Total	26	53	101	153	201	248	294	331	363	390	408	442

FTOST

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	7	7	7	6	4	0	0	0	0	0	0	0
LTjg	7	12	18	16	11	6	5	1	0	0	0	0
LT	2	7	14	24	30	35	34	29	24	15	6	3
LCDR	0	0	0	0	0	3	4	9	12	11	14	16
CDR	0	0	0	0	0	0	0	0	0	0	1	1
Total	16	26	39	46	45	44	43	39	36	26	21	20

NCP Totals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	0	0	0	20	47	67	80	80	87	75	67	85
LTjg	0	0	0	0	0	21	47	67	81	84	90	77
LT	0	0	0	0	0	0	0	21	41	78	105	129
LCDR	0	0	0	0	0	0	0	0	0	0	0	0
CDR	0	0	0	0	0	0	0	0	0	0	0	0
Totals	0	0	0	20	47	88	127	168	209	237	262	291

Recall Totals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	7	0	2	2	0	2	1	3	0	1	0	1
LTjg	24	18	13	3	4	3	5	2	2	4	5	3
LT	30	51	57	67	57	50	38	33	27	20	17	19
LCDR	0	0	1	4	5	24	47	54	59	61	65	52
CDR	0	0	0	0	0	0	0	0	1	1	3	9
Totals	61	69	73	76	66	79	91	92	89	87	90	84

ROTC Totals

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	1	6	11	15	29	83	141	170	152	116	93	71
LTjg	0	0	1	6	11	14	28	81	145	166	150	124
LT	0	0	0	0	1	5	9	17	26	70	132	191
LCDR	0	0	0	0	0	0	0	0	0	0	0	3
CDR	0	0	0	0	0	0	0	0	0	0	0	0
Totals	1	6	12	21	41	102	178	268	323	352	375	389

Totals for All Accession Sources

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ENS	189	285	251	238	249	439	520	440	359	308	302	296
LTjg	90	126	268	312	259	256	278	463	557	457	392	348

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APPENDIX G – REGRESSION RESULTS AND DESCRIPTIVE STATISTICS

J0 leaving (First Year LTs leaving)

1974 total JO 184 leaving - 9% 1790 staying
Classification Table: model predicts accurately 75% 80%
R-Square 0.2068 Max-rescaled R-Square 0.4477
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-2.6496	0.7950	11.1079	0.0009
DirectNoBonus	1	0.5841	0.5166	1.2786	0.2582
BDCP	1	1.5868	0.3080	26.5417	<.0001
DirectBonus	1	0.9758	0.2903	11.3005	0.0008
NCanProg	1	-1.0286	0.5727	3.2264	0.0725
FTCST	1	-12.0822	540.1	0.0005	0.9822
MECP	1	0.5465	0.4375	1.5601	0.2116
Recall	1	-0.2788	0.7409	0.1416	0.7067
Male	1	-0.0897	0.2506	0.1280	0.7205
White	1	0.0231	0.2612	0.0078	0.9296
J0ActiveSpouse	1	-1.6116	0.5704	7.9824	0.0047
Doctor	0	0	.	.	.
Master	1	-0.0141	1.3569	0.0001	0.9917
Diploma	1	0.1266	0.7111	0.0317	0.8587
J0critical	1	-0.4934	0.1990	6.1441	0.0132
J0unem	1	0.3534	0.1377	6.5913	0.0102
J0dep	1	-2.3213	0.1965	139.5619	<.0001
J0Married	1	0.0519	0.3648	0.0203	0.8868
ENTRY_AGE	1	0.00538	0.0221	0.0595	0.8072

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-2.6496	0.7950	11.1079	0.0005
DirectNoBonus	1	0.5841	0.5166	1.2786	0.1291
BDCP	1	1.5868	0.3080	26.5417	<.0001
DirectBonus	1	0.9758	0.2903	11.3005	0.0004
NCanProg	1	-1.0286	0.5727	3.2264	0.03625
FTCST	1	-12.0822	540.1	0.0005	0.4911
MECP	1	0.5465	0.4375	1.5601	0.1058
Recall	1	-0.2788	0.7409	0.1416	0.3534
Male	1	-0.0897	0.2506	0.1280	0.3603
White	1	0.0231	0.2612	0.0078	0.4648
J0ActiveSpouse	1	-1.6116	0.5704	7.9824	0.0023
Doctor	0	0	.	.	.
Master	1	-0.0141	1.3569	0.0001	0.4959
Diploma	1	0.1266	0.7111	0.0317	0.4293
J0critical	1	-0.4934	0.1990	6.1441	0.0132
J0unem	1	0.3534	0.1377	6.5913	0.0066
J0dep	1	-2.3213	0.1965	139.5619	<.0001
J0Married	1	0.0519	0.3648	0.0203	0.4434
ENTRY_AGE	1	0.00538	0.0221	0.0595	0.4036

Descriptive Statistics for Continuous Variables

J0 Leave

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.052152	0.222390	0	1.000000
BDCP	0.308354	0.461931	0	1.000000
DirectBonus	0.230380	0.421183	0	1.000000
NCanProg	0.081013	0.272924	0	1.000000
FTCST	0.013671	0.116150	0	1.000000
MECP	0.164051	0.370415	0	1.000000
Recall	0.018734	0.135619	0	1.000000
Male	0.316456	0.465211	0	1.000000
White	0.852152	0.355039	0	1.000000
J0ActiveSpouse	0.114430	0.318414	0	1.000000
Doctor	0	0	0	0
Master	0.014684	0.120313	0	1.000000
Diploma	0.022785	0.149255	0	1.000000
J0critical	0.433924	0.495740	0	1.000000
J0unem	5.023089	0.817646	4.000000	7.500000
J0dep	1.934177	1.565756	0	8.000000
J0Married	0.555949	0.496986	0	1.000000
ENTRY_AGE	23.977722	5.105127	17	35.000000

J1 leaving (Second Year LTs leaving)

1880 total J1 224 leaving - 12% 1656 staying
Classification Table: model predicts accurately 87%
R-Square 0.3121 Max-rescaled R-Square 0.6022
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-2.9262	0.8938	10.7174	0.0011
DirectNoBonus	1	1.4090	0.4828	8.5172	0.0035
BDCP	1	2.0079	0.3326	36.4531	<.0001
DirectBonus	1	0.7319	0.3010	5.9119	0.0150
NCanProg	1	1.0247	0.3728	7.5542	0.0060
MECP	1	0.6467	0.5117	1.5974	0.2063
Recall	1	-0.6186	0.6947	0.7929	0.3732
Male	1	-0.5727	0.2845	4.0516	0.0441
White	1	0.1826	0.3046	0.3594	0.5488
J1ActiveSpouse	1	-1.7389	0.7330	5.6274	0.0177
Doctor	0	0	.	.	.
Master	1	-0.2657	0.9254	0.0824	0.7740
Diploma	1	-0.4931	0.6638	0.5519	0.4576
J1critical	1	-0.4317	0.2017	4.5820	0.0323
J1unem	1	0.5055	0.1657	9.3086	0.0023
J1dep	1	-3.5528	0.2824	158.2365	<.0001
J1Married	1	-1.1188	0.3442	10.5670	0.0012
ENTRY_AGE	1	-0.00115	0.0210	0.0030	0.9564

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-2.9262	0.8938	10.7174	0.0006
DirectNoBonus	1	1.4090	0.4828	8.5172	0.0018
BDCP	1	2.0079	0.3326	36.4531	<.0001
DirectBonus	1	0.7319	0.3010	5.9119	0.0075
NCanProg	1	1.0247	0.3728	7.5542	0.0030
MECP	1	0.6467	0.5117	1.5974	0.1032
Recall	1	-0.6186	0.6947	0.7929	0.1866
Male	1	-0.5727	0.2845	4.0516	0.0221
White	1	0.1826	0.3046	0.3594	0.2744
J1ActiveSpouse	1	-1.7389	0.7330	5.6274	0.0089
Doctor	0	0	.	.	.
Master	1	-0.2657	0.9254	0.0824	0.3870
Diploma	1	-0.4931	0.6638	0.5519	0.2288
J1critical	1	-0.4317	0.2017	4.5820	0.0162
J1unem	1	0.5055	0.1657	9.3086	0.0012
J1dep	1	-3.5528	0.2824	158.2365	<.0001
J1Married	1	-1.1188	0.3442	10.5670	0.0006
ENTRY_AGE	1	-0.00115	0.0210	0.0030	0.4782

Descriptive Statistics for Continuous Variables

J1 Leave

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.069149	0.253775	0	1.000000
BDCP	0.294681	0.456020	0	1.000000
DirectBonus	0.260106	0.438809	0	1.000000
NCanProg	0.063298	0.243563	0	1.000000
MECP	0.149468	0.356644	0	1.000000
Recall	0.036170	0.186763	0	1.000000
Male	0.311702	0.463312	0	1.000000
White	0.855851	0.351334	0	1.000000
J1ActiveSpouse	0.102128	0.302897	0	1.000000
Doctor	0	0	0	0
Master	0.037234	0.189385	0	1.000000
Diploma	0.049468	0.216901	0	1.000000
J1critical	0.517021	0.499843	0	1.000000
J1unem	4.974681	0.873090	4.000000	7.500000
J1dep	1.970213	1.650444	0	8.000000
J1Married	0.557979	0.496759	0	1.000000
ENTRY_AGE	24.609043	5.620311	17	35.000000

J2 leaving (Third Year LTs leaving)

1493 total J2 151 leaving - 10% 1342 staying
Classification Table: model predicts accurately 86%
R-Square 0.2719 Max-rescaled R-Square 0.5657
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-3.5805	1.1182	10.2534	0.0014
DirectNoBonus	1	1.2374	0.5498	5.0655	0.0244
BDCP	1	1.2581	0.4379	8.2561	0.0041
DirectBonus	1	0.6727	0.4356	2.3846	0.1225
NCanProg	1	0.9464	0.5562	2.8950	0.0889
FTCST	1	3.3620	2.0290	2.7454	0.0975
MECP	1	-0.8686	1.1279	0.5931	0.4412
recall	1	0.3031	0.7090	0.1827	0.6690
Male	1	-0.8304	0.3415	5.9142	0.0150
White	1	0.00503	0.3478	0.0002	0.9885
J2ActiveSpouse	1	-1.7786	1.1686	2.3163	0.1280
Doctor	0	0	.	.	.
Master	1	-2.3549	2.0100	1.3726	0.2414
Diploma	1	-0.5348	0.6521	0.6727	0.4121
J2critical	1	-0.2430	0.2272	1.1440	0.2848
J2unem	1	0.4223	0.1986	4.5194	0.0335
J2dep	1	-2.6994	0.2767	95.1827	<.0001
J2Married	1	-0.9909	0.5257	3.5535	0.0594
ENTRY_AGE	1	0.0398	0.0230	2.9930	0.0836

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-3.5805	1.1182	10.2534	0.0014
DirectNoBonus	1	1.2374	0.5498	5.0655	0.0122
BDCP	1	1.2581	0.4379	8.2561	0.002
DirectBonus	1	0.6727	0.4356	2.3846	0.0612
NCanProg	1	0.9464	0.5562	2.8950	0.0444
FTCST	1	3.3620	2.0290	2.7454	0.04875
MECP	1	-0.8686	1.1279	0.5931	0.2206
Recall	1	0.3031	0.7090	0.1827	0.3345
Male	1	-0.8304	0.3415	5.9142	0.0075
White	1	0.00503	0.3478	0.0002	0.4942
J2ActiveSpouse	1	-1.7786	1.1686	2.3163	0.064
Doctor	0	0	.	.	.
Master	1	-2.3549	2.0100	1.3726	0.1207
Diploma	1	-0.5348	0.6521	0.6727	0.2065
J2critical	1	-0.2430	0.2272	1.1440	0.1424
J2unem	1	0.4223	0.1986	4.5194	0.0168
J2dep	1	-2.6994	0.2767	95.1827	<.0001
J2Married	1	-0.9909	0.5257	3.5535	0.0297
ENTRY_AGE	1	0.0398	0.0230	2.9930	0.0418

Descriptive Statistics for Continuous Variables

J2 Leave

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.074347	0.262423	0	1.000000
BDCP	0.320161	0.466694	0	1.000000
DirectBonus	0.259879	0.438715	0	1.000000
NCanProg	0.040188	0.196465	0	1.000000
FTCST	0.029471	0.169179	0	1.000000
MECP	0.151373	0.358532	0	1.000000
Recall	0.052914	0.223936	0	1.000000
Male	0.322840	0.467719	0	1.000000
White	0.864032	0.342869	0	1.000000
J2ActiveSpouse	0.095780	0.294388	0	1.000000
Doctor	0	0	0	0
Master	0.045546	0.208568	0	1.000000
Diploma	0.058272	0.234335	0	1.000000
J2critical	0.603483	0.489338	0	1.000000
J2unem	4.901273	0.824616	4.000000	7.500000
J2dep	2.102478	1.672864	0	8.000000
J2Married	0.594106	0.491229	0	1.000000
ENTRY_AGE	24.972539	5.909838	17	35.000000

J3 leaving (Fourth Year LTs leaving)

1154 total J3 124 leaving - 11% 1030 staying
Classification Table: model predicts accurately 91%
R-Square 0.3611 Max-rescaled R-Square 0.7301
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-4.3261	1.6890	6.5607	0.0104
DirectNoBonus	1	0.1265	0.9712	0.0170	0.8964
BDCP	1	1.1595	0.7864	2.1743	0.1403
DirectBonus	1	1.1022	0.8089	1.8568	0.1730
NCanProg	1	-0.3517	1.0241	0.1179	0.7313
FTCST	1	2.6165	1.2784	4.1889	0.0407
MECP	1	-0.1723	1.1304	0.0232	0.8789
recall	1	-0.0355	1.1939	0.0009	0.9763
Male	1	-0.6773	0.4043	2.8061	0.0939
White	1	0.6563	0.4668	1.9763	0.1598
Doctor	1	-10.1891	1273.2	0.0001	0.9936
Master	1	-1.2491	0.7504	2.7710	0.0960
Diploma	1	0.7557	0.6209	1.4814	0.2236
J3critical	1	-0.2113	0.3074	0.4726	0.4918
J3unem	1	0.6723	0.2804	5.7508	0.0165
J3dep	1	-3.8550	0.4265	81.7022	<.0001
J3Married	1	-3.1590	1.0466	9.1100	0.0025
ENTRY_AGE	1	0.0164	0.0326	0.2539	0.6144

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-4.3261	1.6890	6.5607	0.0052
DirectNoBonus	1	0.1265	0.9712	0.0170	0.4482
BDCP	1	1.1595	0.7864	2.1743	0.0702
DirectBonus	1	1.1022	0.8089	1.8568	0.0865
NCanProg	1	-0.3517	1.0241	0.1179	0.3656
FTCST	1	2.6165	1.2784	4.1889	0.0204
MECP	1	-0.1723	1.1304	0.0232	0.4395
recall	1	-0.0355	1.1939	0.0009	0.9763
Male	1	-0.6773	0.4043	2.8061	0.0470
White	1	0.6563	0.4668	1.9763	0.0799
Doctor	1	-10.1891	1273.2	0.0001	0.4968
Master	1	-1.2491	0.7504	2.7710	0.0480
Diploma	1	0.7557	0.6209	1.4814	0.1118
J3critical	1	-0.2113	0.3074	0.4726	0.2459
J3unem	1	0.6723	0.2804	5.7508	0.0083
J3dep	1	-3.8550	0.4265	81.7022	<.0001
J3Married	1	-3.1590	1.0466	9.1100	0.0013
ENTRY_AGE	1	0.0164	0.0326	0.2539	0.3072

Descriptive Statistics for Continuous Variables

J3Leave

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.078856	0.269631	0	1.000000
BDCP	0.355286	0.478807	0	1.000000
DirectBonus	0.238302	0.426229	0	1.000000
NCanProg	0.020797	0.142767	0	1.000000
FTCST	0.034662	0.183002	0	1.000000
MECP	0.161179	0.367855	0	1.000000
Recall	0.067591	0.251152	0	1.000000
Male	0.337088	0.472920	0	1.000000
White	0.864818	0.342066	0	1.000000
Doctor	0.000867	0.029437	0	1.000000
Master	0.131716	0.338328	0	1.000000
Diploma	0.071924	0.258474	0	1.000000
J3critical	0.677643	0.467581	0	1.000000
J3unem	4.773224	0.753726	4.000000	7.500000
J3dep	2.186308	1.694065	0	8.000000
J3Married	0.585789	0.492799	0	1.000000
ENTRY_AGE	25.168977	6.281352	17	35.000000

K2 leaving (Third Year LTJG leaving)

827 total K2 234 leaving - 11% 593 staying
Classification Table: model predicts accurately 75% 80%
R-Square 0.5757 Max-rescaled R-Square 0.8269
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-0.1595	1.3272	0.0144	0.9044
DirectNoBonus	1	-1.2038	0.7501	2.5757	0.1085
BDCP	1	0.5836	0.6124	0.9082	0.3406
DirectBonus	1	-1.5080	0.6446	5.4731	0.0193
NCanProg	1	-2.9647	0.9559	9.6194	0.0019
FTCST	1	-2.2799	1.4439	2.4933	0.1143
MECP	1	-1.3367	0.8603	2.4143	0.1202
Recall	1	-3.8851	1.2794	9.2211	0.0024
Male	1	0.0458	0.4390	0.0109	0.9170
White	1	-0.0960	0.4281	0.0503	0.8226
Diploma	1	-0.1538	0.8461	0.0331	0.8557
K2critical	1	-0.6102	0.3510	3.0212	0.0822
K2unem	1	0.7427	0.2229	11.1048	0.0009
K2dep	1	-4.5292	0.3978	129.6563	<.0001
K2Married	1	-0.3340	0.6236	0.2867	0.5923
ENTRY_AGE	1	-0.0499	0.0389	1.6392	0.2004

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-0.1595	1.3272	0.0144	0.4522
DirectNoBonus	1	-1.2038	0.7501	2.5757	0.0543
BDCP	1	0.5836	0.6124	0.9082	0.1703
DirectBonus	1	-1.5080	0.6446	5.4731	0.0097
NCanProg	1	-2.9647	0.9559	9.6194	0.00095
FTCST	1	-2.2799	1.4439	2.4933	0.0572
MECP	1	-1.3367	0.8603	2.4143	0.0601
Recall	1	-3.8851	1.2794	9.2211	0.0012
Male	1	0.0458	0.4390	0.0109	0.4585
White	1	-0.0960	0.4281	0.0503	0.4113
Diploma	1	-0.1538	0.8461	0.0331	0.4278
K2critical	1	-0.6102	0.3510	3.0212	0.0411
K2unem	1	0.7427	0.2229	11.1048	0.00045
K2dep	1	-4.5292	0.3978	129.6563	<.0001
K2Married	1	-0.3340	0.6236	0.2867	0.2961
ENTRY_AGE	1	-0.0499	0.0389	1.6392	0.1002

Descriptive Statistics for Continuous Variables

K2 leave

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.087062	0.282096	0	1.000000
BDCP	0.366385	0.482108	0	1.000000
DirectBonus	0.287787	0.453005	0	1.000000
NCanProg	0.066505	0.249314	0	1.000000
FTCST	0.024184	0.153712	0	1.000000
MECP	0.065296	0.247197	0	1.000000
Recall	0.024184	0.153712	0	1.000000
Male	0.274486	0.446525	0	1.000000
White	0.850060	0.357228	0	1.000000
Diploma	0.071342	0.257551	0	1.000000
K2critical	0.385732	0.487062	0	1.000000
K2unem	5.331197	0.976922	4.000000	7.500000
K2dep	1.561064	1.590554	0	7.000000
K2Married	0.408706	0.491892	0	1.000000
ENTRY_AGE	25.097944	5.470266	17	35.000000

L1 Promoting (Second Year ENS Promoting)

2771 total 2123 promote - 77% 648 staying
Classification Table: model predicts accurately 56%
R-Square 0.0472 Max-rescaled R-Square 0.0711
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-0.4466	0.3366	1.7603	0.1846
DirectNoBonus	1	-1.0070	0.2171	21.5248	<.0001
BDCP	1	-0.3209	0.1817	3.1195	0.0774
DirectBonus	1	-0.8972	0.1675	28.7043	<.0001
NCanProg	1	-0.7609	0.1819	17.5057	<.0001
FTCST	1	-1.3519	0.5872	5.3000	0.0213
MECP	1	-0.0555	0.1864	0.0885	0.7660
Recall	1	1.1008	1.0541	1.0906	0.2963
Male	1	-0.2232	0.1077	4.2991	0.0381
White	1	0.4054	0.1207	11.2717	0.0008
L1ActiveSpouse	1	0.2099	0.2460	0.7275	0.3937
Doctor	0	0	.	.	.
Master	1	-12.5658	265.1	0.0022	0.9622
Diploma	1	0.1160	0.4252	0.0744	0.7850
L1critical	1	-0.0273	0.2413	0.0128	0.9101
L1unem	1	0.1235	0.0564	4.7947	0.0285
L1dep	1	-0.1108	0.0521	4.5166	0.0336
L1Married	1	0.2489	0.1391	3.2034	0.0735
ENTRY_AGE	1	0.0524	0.00767	46.6066	<.0001

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-0.4466	0.3366	1.7603	0.0923
DirectNoBonus	1	-1.0070	0.2171	21.5248	<.0001
BDCP	1	-0.3209	0.1817	3.1195	0.0387
DirectBonus	1	-0.8972	0.1675	28.7043	<.0001
NCanProg	1	-0.7609	0.1819	17.5057	<.0001
FTCST	1	-1.3519	0.5872	5.3000	0.0106
MECP	1	-0.0555	0.1864	0.0885	0.3830
Recall	1	1.1008	1.0541	1.0906	0.14815
Male	1	-0.2232	0.1077	4.2991	0.01905
White	1	0.4054	0.1207	11.2717	0.0004
L1ActiveSpouse	1	0.2099	0.2460	0.7275	0.1969
Doctor	0	0	.	.	.
Master	1	-12.5658	265.1	0.0022	0.4811
Diploma	1	0.1160	0.4252	0.0744	0.3925
L1critical	1	-0.0273	0.2413	0.0128	0.4551
L1unem	1	0.1235	0.0564	4.7947	0.0142
L1dep	1	-0.1108	0.0521	4.5166	0.0168
L1Married	1	0.2489	0.1391	3.2034	0.0368
ENTRY_AGE	1	0.0524	0.00767	46.6066	<.0001

Descriptive Statistics for Continuous Variables

L1 Promote

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.060267	0.238024	0	1.000000
BDCP	0.315049	0.464619	0	1.000000
DirectBonus	0.193071	0.394780	0	1.000000
NCanProg	0.101047	0.301445	0	1.000000
FTCST	0.005413	0.073388	0	1.000000
MECP	0.158066	0.364868	0	1.000000
Recall	0.005052	0.070913	0	1.000000
Male	0.311801	0.463313	0	1.000000
White	0.840852	0.365880	0	1.000000
L1ActiveSpouse	0.061711	0.240673	0	1.000000
Doctor	0	0	0	0
Master	0.000361	0.018997	0	1.000000
Diploma	0.011909	0.108496	0	1.000000
L1critical	0.040058	0.196130	0	1.000000
L1unem	5.818441	1.085801	4.000000	7.500000
L1dep	1.804042	1.286783	0	7.000000
L1Married	0.420426	0.493716	0	1.000000
ENTRY_AGE	23.128834	5.903343	17	35.000000

L2 Promoting (Third Year ENS Promoting)

549 total 481 promote - 88% 68 staying
Classification Table: model predicts accurately 79%
R-Square 0.2467 Max-rescaled R-Square 0.4679
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-4.3261	1.6890	6.5607	0.0104
DirectNoBonus	1	0.1265	0.9712	0.0170	0.8964
BDCP	1	1.1595	0.7864	2.1743	0.1403
DirectBonus	1	1.1022	0.8089	1.8568	0.1730
NCanProg	1	-0.3517	1.0241	0.1179	0.7313
FTCST	1	2.6165	1.2784	4.1889	0.0407
MECP	1	-0.1723	1.1304	0.0232	0.8789
recall	1	-0.0355	1.1939	0.0009	0.9763
Male	1	-0.6773	0.4043	2.8061	0.0939
White	1	0.6563	0.4668	1.9763	0.1598
Doctor	1	-10.1891	1273.2	0.0001	0.9936
Master	1	-1.2491	0.7504	2.7710	0.0960
Diploma	1	0.7557	0.6209	1.4814	0.2236
J3critical	1	-0.2113	0.3074	0.4726	0.4918
J3unem	1	0.6723	0.2804	5.7508	0.0165
J3dep	1	-3.8550	0.4265	81.7022	<.0001
J3Married	1	-3.1590	1.0466	9.1100	0.0025
ENTRY_AGE	1	0.0164	0.0326	0.2539	0.6144

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-4.3261	1.6890	6.5607	0.0052
DirectNoBonus	1	0.1265	0.9712	0.0170	0.4482
BDCP	1	1.1595	0.7864	2.1743	0.0702
DirectBonus	1	1.1022	0.8089	1.8568	0.0865
NCanProg	1	-0.3517	1.0241	0.1179	0.3656
FTCST	1	2.6165	1.2784	4.1889	0.0204
MECP	1	-0.1723	1.1304	0.0232	0.4395
recall	1	-0.0355	1.1939	0.0009	0.4882
Male	1	-0.6773	0.4043	2.8061	0.0470
White	1	0.6563	0.4668	1.9763	0.0799
Doctor	1	-10.1891	1273.2	0.0001	0.4968
Master	1	-1.2491	0.7504	2.7710	0.0480
Diploma	1	0.7557	0.6209	1.4814	0.1118
J3critical	1	-0.2113	0.3074	0.4726	0.2459
J3unem	1	0.6723	0.2804	5.7508	0.0083
J3dep	1	-3.8550	0.4265	81.7022	<.0001
J3Married	1	-3.1590	1.0466	9.1100	0.0013
ENTRY_AGE	1	0.0164	0.0326	0.2539	0.3072

Descriptive Statistics for Continuous Variables

L2 promo

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.103825	0.305312	0	1.000000
BDCP	0.298725	0.458116	0	1.000000
DirectBonus	0.285974	0.452289	0	1.000000
NCanProg	0.100182	0.300517	0	1.000000
MECP	0.109290	0.312287	0	1.000000
Male	0.324226	0.468512	0	1.000000
White	0.817851	0.386320	0	1.000000
L2ActiveSpouse	0.058288	0.234501	0	1.000000
Diploma	0.014572	0.119941	0	1.000000
L2critical	0.109290	0.312287	0	1.000000
L2unem	5.681421	1.056618	4.000000	7.500000
L2dep	1.746812	1.402427	0	6.000000
L2Married Total	0.415301	0.493223	0	1.00000
ENTRY_AGE	24.588342	4.879752	17	35.000000

K1 Promoting (Second Year LTJG Promoting)

2623 total 1647 promote - 63% 976 staying
Classification Table: model predicts accurately 56%
R-Square 0.0430 Max-rescaled R-Square 0.0587
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	1.1444	0.3338	11.7520	0.0006
DirectNoBonus	1	-0.5920	0.2110	7.8762	0.0050
BDCP	1	-0.2453	0.1507	2.6507	0.1035
DirectBonus	1	-0.1438	0.1558	0.8512	0.3562
NCanProg	1	-0.4968	0.1813	7.5089	0.0061
FTOST	1	-0.6436	0.4375	2.1647	0.1412
MECP	1	0.3827	0.1816	4.4416	0.0351
Recall	1	-0.7174	0.3587	4.0009	0.0455
Male	1	-0.2262	0.1007	5.0447	0.0247
White	1	0.1295	0.1164	1.2392	0.2656
K1ActiveSpouse	1	0.5211	0.1636	10.1499	0.0014
Doctor	0	0	.	.	.
Master	1	0.7150	0.5438	1.7287	0.1886
Diploma	1	-0.4026	0.2529	2.5352	0.1113
K1critical	1	0.4338	0.0949	20.8827	<.0001
K1unem	1	-0.1272	0.0531	5.7331	0.0166
K1dep	1	0.1490	0.0430	11.9896	0.0005
K1Married	1	-0.0499	0.1183	0.1778	0.6733
ENTRY_AGE	1	-0.0108	0.00893	1.4600	0.2269

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	1.1444	0.3338	11.7520	0.0003
DirectNoBonus	1	-0.5920	0.2110	7.8762	0.0025
BDCP	1	-0.2453	0.1507	2.6507	0.0517
DirectBonus	1	-0.1438	0.1558	0.8512	0.1781
NCanProg	1	-0.4968	0.1813	7.5089	0.0031
FTOST	1	-0.6436	0.4375	2.1647	0.0706
MECP	1	0.3827	0.1816	4.4416	0.0176
Recall	1	-0.7174	0.3587	4.0009	0.0228
Male	1	-0.2262	0.1007	5.0447	0.0123
White	1	0.1295	0.1164	1.2392	0.1328
K1ActiveSpouse	1	0.5211	0.1636	10.1499	0.0007
Doctor	0	0	.	.	.
Master	1	0.7150	0.5438	1.7287	0.0943
Diploma	1	-0.4026	0.2529	2.5352	0.0556
K1critical	1	0.4338	0.0949	20.8827	<.0001
K1unem	1	-0.1272	0.0531	5.7331	0.0083
K1dep	1	0.1490	0.0430	11.9896	0.0003
K1Married	1	-0.0499	0.1183	0.1778	0.3367
ENTRY_AGE	1	-0.0108	0.00893	1.4600	0.1135

Descriptive Statistics for Continuous Variables

K1 promote

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.062143	0.241460	0	1.000000
BDCP	0.320625	0.466806	0	1.000000
DirectBonus	0.232939	0.422785	0	1.000000
NCanProg	0.080442	0.272028	0	1.000000
FTOST	0.014106	0.117950	0	1.000000
MECP	0.140679	0.347756	0	1.000000
Recall	0.014487	0.119511	0	1.000000

Male	0.299276	0.458028	0	1.000000
White	0.850934	0.356221	0	1.000000
K1ActiveSpouse	0.110560	0.313647	0	1.000000
Doctor	0	0	0	0
Master	0.009150	0.095234	0	1.000000
Diploma	0.028212	0.165610	0	1.000000
K1critical	0.307663	0.461614	0	1.000000
K1unem	5.348075	0.941716	4.000000	7.500000
K1dep	2.005337	1.421735	0	8.000000
K1Married	0.548990	0.497689	0	1.000000
ENTRY_AGE	24.017156	5.100449	17	35.000000

K2 Promoting (Third Year LTJG Promoting)

827 total 504 promote - 61% 323 staying
Classification Table: model predicts accurately 79%
R-Square 0.3675 Max-rescaled R-Square 0.4982
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-0.6430	0.7608	0.7143	0.3980
DirectNoBonus	1	0.4594	0.4645	0.9780	0.3227
BDCP	1	-0.8949	0.3633	6.0679	0.0138
DirectBonus	1	0.7999	0.3862	4.2897	0.0383
NCanProg	1	0.7219	0.4899	2.1718	0.1406
FTOST	1	0.5024	0.8874	0.3206	0.5713
MECP	1	0.5793	0.5104	1.2882	0.2564
Recall	1	1.8768	0.8149	5.3045	0.0213
Male	1	-0.1171	0.2338	0.2509	0.6164
White	1	0.0867	0.2669	0.1055	0.7453
K2ActiveSpouse	1	1.9293	0.4715	16.7410	<.0001
Doctor	0	0	.	.	.
Master	1	0.8680	1.2130	0.5121	0.4742
Diploma	1	0.6720	0.4815	1.9478	0.1628
K2critical	1	0.7438	0.2019	13.5674	0.0002
K2unem	1	-0.2704	0.1209	5.0055	0.0253
K2dep	1	1.0116	0.1321	58.6357	<.0001
K2Married	1	-0.5303	0.3315	2.5592	0.1097
ENTRY_AGE	1	0.0380	0.0206	3.4118	0.0647

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-0.6430	0.7608	0.7143	0.1990
DirectNoBonus	1	0.4594	0.4645	0.9780	0.1614
BDCP	1	-0.8949	0.3633	6.0679	0.007
DirectBonus	1	0.7999	0.3862	4.2897	0.0192
NCanProg	1	0.7219	0.4899	2.1718	0.0703
FTOST	1	0.5024	0.8874	0.3206	0.2857
MECP	1	0.5793	0.5104	1.2882	0.1282
Recall	1	1.8768	0.8149	5.3045	0.0107
Male	1	-0.1171	0.2338	0.2509	0.3082
White	1	0.0867	0.2669	0.1055	0.3727
K2ActiveSpouse	1	1.9293	0.4715	16.7410	<.0001
Doctor	0	0	.	.	.
Master	1	0.8680	1.2130	0.5121	0.2371
Diploma	1	0.6720	0.4815	1.9478	0.0814
K2critical	1	0.7438	0.2019	13.5674	0.0001
K2unem	1	-0.2704	0.1209	5.0055	0.0127
K2dep	1	1.0116	0.1321	58.6357	<.0001
K2Married	1	-0.5303	0.3315	2.5592	0.0549
ENTRY_AGE	1	0.0380	0.0206	3.4118	0.0324

Descriptive Statistics for Continuous Variables

K2 promote

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.087062	0.282096	0	1.000000
BDCP	0.366385	0.482108	0	1.000000
DirectBonus	0.287787	0.453005	0	1.000000
NCanProg	0.066505	0.249314	0	1.000000
FTCST	0.024184	0.153712	0	1.000000
MECP	0.065296	0.247197	0	1.000000
Recall	0.024184	0.153712	0	1.000000
Male	0.274486	0.446525	0	1.000000
White	0.850060	0.357228	0	1.000000
K2ActiveSpouse	0.068924	0.253478	0	1.000000
Doctor	0	0	0	0
Master	0.018138	0.133531	0	1.000000
Diploma	0.071342	0.257551	0	1.000000
K2critical	0.385732	0.487062	0	1.000000
K2unem	5.331197	0.976922	4.000000	7.500000
K2dep	1.561064	1.590554	0	7.000000
K2Married	0.408706	0.491892	0	1.000000
ENTRY_AGE	25.097944	5.470266	17	35.000000

J5 Promoting (Sixth Year LT Promoting)

595 total 233 promote - 39% 362 staying
Classification Table: model predicts accurately 65%
R-Square 0.1684 Max-rescaled R-Square 0.2282
Testing Global Null Hypothesis: BETA = 0, Likelihood Ratio Pr>ChiSq - <.0001

Analysis of Maximum Likelihood Estimates (two tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	3.4854	1.2016	8.4140	0.0037
DirectNoBonus	1	-0.3357	0.8558	0.1538	0.6949
BDCP	1	-0.6616	0.8123	0.6633	0.4154
DirectBonus	1	0.2624	0.8230	0.1016	0.7499
NCanProg	0	0	.	.	.
FTCST	1	0.4012	0.9383	0.1828	0.6690
MECP	1	-0.5861	0.8480	0.4778	0.4894
Recall	1	1.0165	0.8725	1.3574	0.2440
Male	1	-0.5003	0.2310	4.6910	0.0303
White	1	0.6533	0.3052	4.5823	0.0323
J5ActiveSpouse	1	0.2879	0.3584	0.6455	0.4217
Doctor	1	0.9901	1.4393	0.4732	0.4915
Master	1	1.0313	0.2323	19.7061	<.0001
Diploma	1	-0.8736	0.4056	4.6395	0.0312
J5critical	1	0.1462	0.2255	0.4200	0.5169
J5unem	1	-1.2407	0.1896	42.8079	<.0001
J5dep	1	0.2651	0.0807	10.7864	0.0010
J5Married	1	-0.2723	0.2798	0.9473	0.3304
ENTRY_AGE	1	0.0298	0.0153	3.8112	0.0509

Analysis of Maximum Likelihood Estimates (one tailed)

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	3.4854	1.2016	8.4140	0.0018
DirectNoBonus	1	-0.3357	0.8558	0.1538	0.3475
BDCP	1	-0.6616	0.8123	0.6633	0.2077
DirectBonus	1	0.2624	0.8230	0.1016	0.3749
NCanProg	0	0	.	.	.
FTCST	1	0.4012	0.9383	0.1828	0.3345
MECP	1	-0.5861	0.8480	0.4778	0.2447
Recall	1	1.0165	0.8725	1.3574	0.1220
Male	1	-0.5003	0.2310	4.6910	0.0152
White	1	0.6533	0.3052	4.5823	0.0162
J5ActiveSpouse	1	0.2879	0.3584	0.6455	0.2109
Doctor	1	0.9901	1.4393	0.4732	0.2458
Master	1	1.0313	0.2323	19.7061	<.0001
Diploma	1	-0.8736	0.4056	4.6395	0.0156
J5critical	1	0.1462	0.2255	0.4200	0.2585
J5unem	1	-1.2407	0.1896	42.8079	<.0001
J5dep	1	0.2651	0.0807	10.7864	0.0005
J5Married	1	-0.2723	0.2798	0.9473	0.1652
ENTRY_AGE	1	0.0298	0.0153	3.8112	0.0255

Descriptive Statistics for Continuous Variables

J5 promote

Variable	Mean	Standard Deviation	Minimum	Maximum
DirectNoBonus	0.095798	0.294562	0	1.000000
BDCP	0.337815	0.473363	0	1.000000
DirectBonus	0.272269	0.445502	0	1.000000
NCanProg	0	0	0	0
FTCST	0.043697	0.204593	0	1.000000
MECP	0.127731	0.334071	0	1.000000
Recall	0.110924	0.314303	0	1.000000
Male	0.317647	0.465953	0	1.000000
White	0.877311	0.328356	0	1.000000
J5ActiveSpouse	0.087395	0.282651	0	1.000000
Doctor	0.005042	0.070888	0	1.000000
Master	0.253782	0.435540	0	1.000000
Diploma	0.077311	0.267309	0	1.000000
J5critical	0.741176	0.438357	0	1.000000
J5unem	4.666218	0.680452	4.000000	7.500000
J5dep	2.114286	1.673837	0	7.000000
J5Married	0.623529	0.484908	0	1.000000
ENTRY_AGE	25.236975	7.188841	17	35.000000

APPENDIX H - PERCENTAGES USED IN MARKOV MODEL CREATION

Highlighted areas denote percentages that were significant, resulting in the use of accession source specific numbers.

ROTC				BDCP		
% Stay	% Prom	% Leaving		% Stay	% Prom	% Leaving
98%	2%	0%	L0	98%	2%	0%
18%	82%	0%	L1	18%	81%	1%
5%	76%	18%	L2	4%	88%	9%
28%	17%	56%	L3	28%	17%	56%
60%	0%	40%	L4	60%	0%	40%
50%	0%	50%	L5	50%	0%	50%
99%	0%	1%	K0	99%	0%	1%
33%	65%	2%	K1	35%	63%	2%
5%	40%	56%	K2	13%	33%	53%
11%	30%	59%	K3	11%	30%	59%
30%	50%	20%	K4	30%	50%	20%
0%	33%	67%	K5	0%	33%	67%
87%	0%	13%	J0	88%	0%	12%
81%	0%	19%	J1	86%	0%	14%
88%	0%	12%	J2	89%	0%	11%
88%	0%	13%	J3	89%	1%	11%
86%	3%	10%	J4	86%	3%	10%
53%	39%	8%	J5	53%	39%	8%
60%	26%	14%	J6	60%	26%	14%
32%	3%	64%	J7	32%	3%	64%
50%	0%	50%	J8	50%	0%	50%
99%	0%	1%	I0	99%	0%	1%
98%	0%	2%	I1	98%	0%	2%
95%	0%	5%	I2	95%	0%	5%
94%	1%	5%	I3	94%	1%	5%
87%	7%	5%	I4	87%	7%	5%
81%	10%	9%	I5	81%	10%	9%
64%	8%	28%	I6	64%	8%	28%
100%	0%	0%	I7	100%	0%	0%
100%	0%	0%	I8	100%	0%	0%
100%	0%	0%	H0	100%	0%	0%
100%	0%	0%	H1	100%	0%	0%
100%	0%	0%	H2	100%	0%	0%
100%	0%	0%	H3	100%	0%	0%
100%	0%	0%	H4	100%	0%	0%

Direct No Bonus

% Stay	% Prom	% Leaving	
98%	2%	0%	L0
32%	68%	0%	L1
4%	88%	9%	L2
28%	17%	56%	L3
60%	0%	40%	L4
50%	0%	50%	L5
99%	0%	1%	K0
40%	50%	10%	K1
12%	60%	28%	K2
11%	30%	59%	K3
30%	50%	20%	K4
0%	33%	67%	K5
91%	0%	9%	J0
89%	0%	12%	J1
86%	0%	14%	J2
89%	1%	11%	J3
86%	3%	10%	J4
53%	39%	8%	J5
60%	26%	14%	J6
32%	3%	64%	J7
50%	0%	50%	J8
99%	0%	1%	I0
98%	0%	2%	I1
95%	0%	5%	I2
94%	1%	5%	I3
87%	7%	5%	I4
81%	10%	9%	I5
64%	8%	28%	I6
100%	0%	0%	I7
100%	0%	0%	I8
100%	0%	0%	H0
100%	0%	0%	H1
100%	0%	0%	H2
100%	0%	0%	H3
100%	0%	0%	H4

Direct Bonus

% Stay	% Prom	% Leaving
98%	2%	0%
30%	70%	1%
4%	88%	9%
28%	17%	56%
60%	0%	40%
50%	0%	50%
99%	0%	1%
35%	63%	2%
15%	76%	10%
11%	30%	59%
30%	50%	20%
0%	33%	67%
86%	0%	14%
87%	0%	13%
88%	0%	12%
89%	1%	11%
86%	3%	10%
53%	39%	8%
60%	26%	14%
32%	3%	64%
50%	0%	50%
99%	0%	1%
98%	0%	2%
95%	0%	5%
94%	1%	5%
87%	7%	5%
81%	10%	9%
64%	8%	28%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%

MECP

% Stay	% Prom	% Leaving	
98%	2%	0%	L0
23%	77%	0%	L1
4%	88%	9%	L2
28%	17%	56%	L3
60%	0%	40%	L4
50%	0%	50%	L5
99%	0%	1%	K0
22%	77%	1%	K1
12%	60%	28%	K2
11%	30%	59%	K3
30%	50%	20%	K4
0%	33%	67%	K5
91%	0%	9%	J0
88%	0%	12%	J1
90%	0%	10%	J2
89%	1%	11%	J3
86%	3%	10%	J4
53%	39%	8%	J5
60%	26%	14%	J6
32%	3%	64%	J7
50%	0%	50%	J8
99%	0%	1%	I0
98%	0%	2%	I1
95%	0%	5%	I2
94%	1%	5%	I3
87%	7%	5%	I4
81%	10%	9%	I5
64%	8%	28%	I6
100%	0%	0%	I7
100%	0%	0%	I8
100%	0%	0%	H0
100%	0%	0%	H1
100%	0%	0%	H2
100%	0%	0%	H3
100%	0%	0%	H4

NCP

% Stay	% Prom	% Leaving
98%	2%	0%
31%	68%	1%
4%	88%	9%
28%	17%	56%
60%	0%	40%
50%	0%	50%
99%	0%	1%
45%	55%	1%
16%	80%	4%
11%	30%	59%
30%	50%	20%
0%	33%	67%
91%	0%	9%
76%	0%	24%
90%	0%	10%
89%	1%	11%
86%	3%	10%
53%	39%	8%
60%	26%	14%
32%	3%	64%
50%	0%	50%
99%	0%	1%
98%	0%	2%
95%	0%	5%
94%	1%	5%
87%	7%	5%
81%	10%	9%
64%	8%	28%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%

FTOST

% Stay	% Prom	% Leaving	
98%	2%	0%	L0
33%	67%	0%	L1
0%	100%	0%	L2

Recall

% Stay	% Prom	% Leaving
98%	2%	0%
23%	77%	0%
4%	88%	9%

28%	17%	56%	L3	28%	17%	56%
60%	0%	40%	L4	60%	0%	40%
50%	0%	50%	L5	50%	0%	50%
99%	0%	1%	K0	99%	0%	1%
35%	63%	2%	K1	42%	47%	11%
12%	60%	28%	K2	5%	85%	10%
11%	30%	59%	K3	11%	30%	59%
30%	50%	20%	K4	30%	50%	20%
0%	33%	67%	K5	0%	33%	67%
91%	0%	9%	J0	91%	0%	9%
88%	0%	12%	J1	88%	0%	12%
90%	0%	10%	J2	90%	0%	10%
88%	0%	13%	J3	89%	1%	11%
86%	3%	10%	J4	86%	3%	10%
53%	39%	8%	J5	53%	39%	8%
60%	26%	14%	J6	60%	26%	14%
32%	3%	64%	J7	32%	3%	64%
50%	0%	50%	J8	50%	0%	50%
99%	0%	1%	I0	99%	0%	1%
98%	0%	2%	I1	98%	0%	2%
95%	0%	5%	I2	95%	0%	5%
94%	1%	5%	I3	94%	1%	5%
87%	7%	5%	I4	87%	7%	5%
81%	10%	9%	I5	81%	10%	9%
64%	8%	28%	I6	64%	8%	28%
100%	0%	0%	I7	100%	0%	0%
100%	0%	0%	I8	100%	0%	0%
100%	0%	0%	H0	100%	0%	0%
100%	0%	0%	H1	100%	0%	0%
100%	0%	0%	H2	100%	0%	0%
100%	0%	0%	H3	100%	0%	0%
100%	0%	0%	H4	100%	0%	0%

APPENDIX I - OVERAGES AND UNDERAGES NOT ALLOWING RANK OPTIMIZATION

Scenario:	Brining in 250 recruits each year for 4 years Distributed as shown below				Overages and Underages
Recruits	Accession Source Distribution		Rank Distribution		
250	MECP	18% (46)	ENS	24%	Over a four year period,
			LTJG	51%	
			LT	25%	Total Overage and Underage
			LCDR	0%	Combined= 1401
	Recall	6% (15)	ENS	13%	
			LTJG	24%	
			LT	57%	
			LCDR	6%	
	Sta-21	5% (12)	ENS	24%	
			LTJG	51%	
			LT	25%	
			LCDR	0%	
	ROTC	19% (47)	ENS	100%	
	NCP	22% (55)	ENS	100%	
	Direct Accession	30% (75)	ENS	100%	
	FTOST	0%	ENS	0%	

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APPENDIX J - OVERAGES AND UNDERAGES ALLOWING RANK OPTIMIZATION

Scenario:	Bringing in 233 recruits every year for 4 years Distributed as shown below				Overages and Underages	
Recruits	Accession Source Distribution		Rank Distribution			
233	MECP	18% (41)	ENS	92.55%	Over a four year period,	
			LTJG	7.45%		
			LT	0.00%	Total Overage and Underage	
			LCDR	0.00%	Combined=	518
	Recall	6% (14)	ENS	0.07%		
			LTJG	1.11%		
			LT	0.00%		
			LCDR	98.82%		
	Sta-21	6% (14)	ENS	96.71%		
			LTJG	3.29%		
			LT	0.00%		
			LCDR	0.00%		
	ROTC	15% (35)	ENS	100.00%		
			LTJG	0.00%		
			LT	0.00%		
			LCDR	0.00%		
	NCP	21% (50)	ENS	96.08%		
			LTJG	3.92%		
			LT	0.00%		
			LCDR	0.00%		
	Direct (with bonus)	15% (35)	ENS	0.22%		
			LTJG	99.78%		
			LT	0.00%		
			LCDR	0.00%		
	Direct (no bonus)	19% (44)	ENS	0.06%		
			LTJG	99.94%		
			LT	0.00%		
			LCDR	0.00%		
	FTOST	0%	ENS	0.00%		

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